Much has been written, debated and discussed about the pros and cons of both Terrestrial Mobile LiDAR (Light Detection and Ranging) Scanning—TMLS and Static Laser Scanning. This is especially evident in the world of transportation survey. However, less information seems to have been presented on the topic of combining these two technologies for documentation of buildings and structures. While each method has its advantages and disadvantages, it begs the question; “When would combining these technologies be advantageous for documenting buildings and structures and when would it not?”

**Why Use Terrestrial Mobile LiDAR Scanning?**

The Mobile LiDAR industry is emerging at a rapid pace. Within only a few short years, mobile scanning has come to represent the promise of significant gains in the speed of data capture, increased productivity, accuracy and efficiency, and substantial improvements in safety. As a result, considerable cost savings in data acquisition can be expected.

The speed of data acquisition of Mobile LiDAR compared to Static Laser Scanning and/or traditional survey methods is significantly faster. Whether the mobile system is mounted on a car, truck, railroad ‘high-rail’, a cart, a backpack, etc., the rate of data capture is astonishing. Project delivery times can also be cut substantially. In addition to quickly gathering tremendous volumes of point cloud data, mobile scanning instruments are often paired with digital video imagery to create colorized point clouds or color-fused, LiDAR mesh imagery.

Since mobile units are by nature “mobile”, they do not require the same labor intensive setup-scan-reposition workflow that static scanners do. As a result mobile systems are very efficient and can be expected to result in a tremendous increase in productivity.
Mobile LiDAR surveying techniques also provide increased safety for surveyors and the general public since data can be acquired remotely, day or night. Mobile scanning methods allow a surveyor to get off site much faster. The reduction in the number of hours spent surveying means a smaller chance for an accident to occur. A reduction in time also means cost savings through lower labor costs, lower travel costs and fewer mobilizations.

**Why Use Static Scanning?**

While mobile scanning has many advantages over static scanning, the same can be said about static scanning over mobile scanning. Static scanners can be used in many places mobile scanners cannot. They are also typically capable of higher resolutions, have improved positional accuracy and require a significantly lower capital investment.

For documentation of buildings and structures, static scanning is often the tool of choice simply due to the fact that mobile systems are limited to where they can be positioned. Crawl spaces beneath the floor, stairs, above ceiling plenum spaces, rooftops, congested mechanical rooms, facades blocked by landscape, etc. all can prove to be difficult or impossible for a mobile unit to access.

The density of the point cloud data obtained with static scanners is generally greater than that of mobile units. This can be very important when documenting buildings and structures. Structural connections, complicated MEP (Mechanical, Electrical, Plumbing) systems, ornate architectural elements as commonly found on building facades will often require very detailed data in order to represent things properly.

Static Laser Scanners don’t change position while scanning, thus they do not require the same sophisticated systems to maintain their position as mobile scanners do. Mobile systems must rely on GPS (Global Positioning System) and an INS (Inertial Navigation System) which adds significantly to the complexity and cost of such systems.

While each of these technologies has its advantages and disadvantages, what can be learned by looking at two real life projects where both Mobile LiDAR and Static Laser Scanning were combined to document structures? The first project, “H Street Bridge”, was a bridge and tunnel renovation for a transportation project in Washington, D.C. The second project “Industrial Arts Building”, was for a HABS (Historic American Building Survey) of an old abandoned Industrial Arts Building located on the grounds of the Nebraska State Fair in Lincoln, Nebraska.

**H Street Bridge Project — Why combining technologies made sense**

Between 1862 and 1962, streetcars in Washington, D.C., were a common mode of transportation, but the system was dismantled in the early 1960s as part of a switch to bus service. In 2003, then-Mayor Anthony A. Williams unveiled a draft Strategic Development Plan which proposed redeveloping and revitalizing six blighted areas of the city, including H Street NE. Among the proposals to revitalize H Street was the construction of a streetcar line to downtown D.C. to be built in five to 10 years.

A portion of the H Street redevelopment project occurs where H Street passes over the railway tracks at the renowned Union Railway Station in Washington, D.C. H Street transitions to a very busy eight lane divided highway as it crosses the bridge. At this location the redevelopment plan calls for the new street car line to tunnel under the existing railway tracks and daylight on the other side. To do this, an old abandon tunnel that runs directly under the H Street Bridge beneath the railway tracks will be re-commissioned to serve the new streetcar line.

Due to the urgency in the project schedule and safety concerns, it was determined that Mobile LiDAR would be the most effective method to document the one mile of roadway and survey the existing bridge and tunnel structures. The Omaha, Nebraska firm of Terrametrix, an expert and pioneer in terrestrial mobile LiDAR, was subcontracted by a local survey company to help document the existing H Street...
Bridge overpass, the abandoned tunnel under H Street, as well as portions of 1st Street NE and 2nd Street NE as they cross under the H Street Bridge on either side of the Union Station railway.

While Mobile LiDAR was an excellent choice for certain aspects of the project, it would be limited to only those locations where a GPS signal could be maintained. This meant that the portions of 1st Street and 2nd Street that passed beneath the H Street Bridge, the tunnel under the railway tracks, as well as some spots on 1st Street and 2nd Street that were subject to the urban canyon effect due to nearby tall buildings which effectively blocks GPS signals would require another method of survey.

Terrametrix turned to its longtime partner, Irvine, California based Architectural Resource Consultants (ARC) for assistance in documenting the portions of the structure that the mobile scanning could not capture. ARC utilized a Leica HDS6000 phase based static laser scanner. A survey control network was established using traditional total station methodology which ARC utilized during the registration process, effectively tying the mobile and static scan data together for modeling.

The combination of both the mobile and static scanning worked well to keep the project on schedule and meet the safety concerns of the team. This is the perfect example of a project that was able to leverage the strengths of both technologies.

Industrial Arts Building Project—Combine Technologies?—Maybe not

For nearly a century, the dramatic trapezoidal exposition space located on the grounds of the Nebraska State Fair has served as a grand showcase for their city’s most important export—agricultural products. Because of it, the architectural features of its Palladian windows, its natural skylights, intricate webbed steel roof trusses and a four-story fountained interior, the National Trust for Historic Preservation named the Industrial Arts Building in Lincoln, Nebraska to its 2010 list of America’s 11 Most Endangered Historic Places.

The unusual trapezoid-shaped building was designed by Omaha architect Burd F. Miller. It features 43-foot ceilings and its interior mezzanine originally was lit with by massive skylights. In addition to its importance to Nebraska’s agriculture history, the Industrial Arts Building has an aviation pedigree. Following World War I, in 1918 the Lincoln Standard Aircraft Company used the building to assemble airplanes, including the plane in which Charles Lindbergh learned to fly.

When the Nebraska State Fair elected to move from its longtime home in Lincoln, ownership of the Industrial Arts Building was transferred to the University of Nebraska, who planned to create a research park called Innovation Campus on the old fairgrounds site. Despite its long history of showcasing innovation, the Industrial Arts Building was not part of the university’s master plan and unless a developer stepped forward to rescue the building for repurpose it would be demolished.

Heritage Nebraska, a statewide non-profit organization under the umbrella of Main Street America submitted the structure for protection when it learned of pending demolition by the new owners. Part of the protection is to record an historic structure through the use of a HABS (Historic American Building Survey) which ensures the preservation through documentation standards for...
quality, content, format, and durability so that future generations will be able to consult the records. The HABS documentation was to include two dimensional floor plans of the basement, 1st Floor and Mezzanine level, a Reflected Ceiling Plan, Roof Plan, Exterior Elevations, Building Sections and both 2D and 3D Details.

In September 2010, the architecture firm of Alley Poyner and Macchietto hired the scanning expertise of Terrametrix, of Omaha, Nebraska and Architectural Resource Consultants (ARC) of Irvine, California to document the 93,500 square foot building as a HABS project. The project team elected, once again, to utilize both mobile and static scanning technologies. Mobile scanning typically wouldn’t be used to document a building such as this; however there were a few factors that swayed the team’s decision to incorporate the mobile system into this project.

The first factor was that the mobile system was available. Since this building was completely surrounded by paved area, maybe, the team thought, some time could be trimmed off the overall data acquisition schedule if the mobile system was used to scan the building exterior while the static scanner was employed on the interior spaces.

Another decision point revolved around how best to document the roof structure. The roof structure was in severe disrepair which made it unsafe to operate a static scanner on the rooftop itself. Furthermore, the shape of the roof structure and position of the rooftop elements would make it difficult to obtain a line-of-sight for the static scanner to capture the needed data from the ground. The fact that the mobile system was mounted on a truck gave it the additional height needed to obtain the required lines-of-sight to capture the needed roof data. The final decision factor was simply the further testing of mobile and static workflows.

The time to mobile scan the exterior of the building was five minutes vs. the ten hours it took to static scan the interior. While the mobile scanner was able to successfully capture the needed roof data, it was determined upon review of the mobile data that it lacked the point density needed to provide an appropriate level of detail required for documentation of the building façade. As a result, the team decided static scanning of the building’s exterior would still be required. However, since two data sets were captured for the building’s exterior, the Team was able to tie both data sets together for a second accuracy check.

Upon completion of the work, the Team determined that the approach taken to utilize both mobile and static scanning on a project of this type was probably unnecessary. Most of what was needed could have been captured with static scanning alone. Given another project of a similar size and complexity, the Team decided it would most likely choose to not employ the mobile method of scanning. However, for a stretch of building facades in an historic downtown area that did not require a HABS level of detail, the Team concluded that it might again consider the combined methodology.

**Conclusion**

While much has been presented about the benefits of both Mobile LiDAR and Static Laser Scanning for the world of transportation survey, the combination of both methods for documenting buildings and structures has room for more testing and commentary. In the two sample projects presented above, one can see an example where combining both technologies clearly had a positive impact. However, it may have been more effective to have maintained a traditional static scanning workflow for the second project. None-the-less, it is important to note that these technologies are still advancing at a rapid pace. What may or may not make sense today could very well become the fastest and most efficient method of tomorrow.

**John M. Russo, AIA,** is an experienced architect and entrepreneur. He founded Architectural Resource Consultants (ARC), a firm that has provided outsourced architectural services to the architectural, engineering, construction and facilities management (AEC+FM) communities since 1997.

**CREDITS:**

Contributing author on the history of the Industrial Arts Building project, Cyn Rene’ Whitfield of Terrametrix.

Historical references for the H Street project were obtained on Wikipedia.