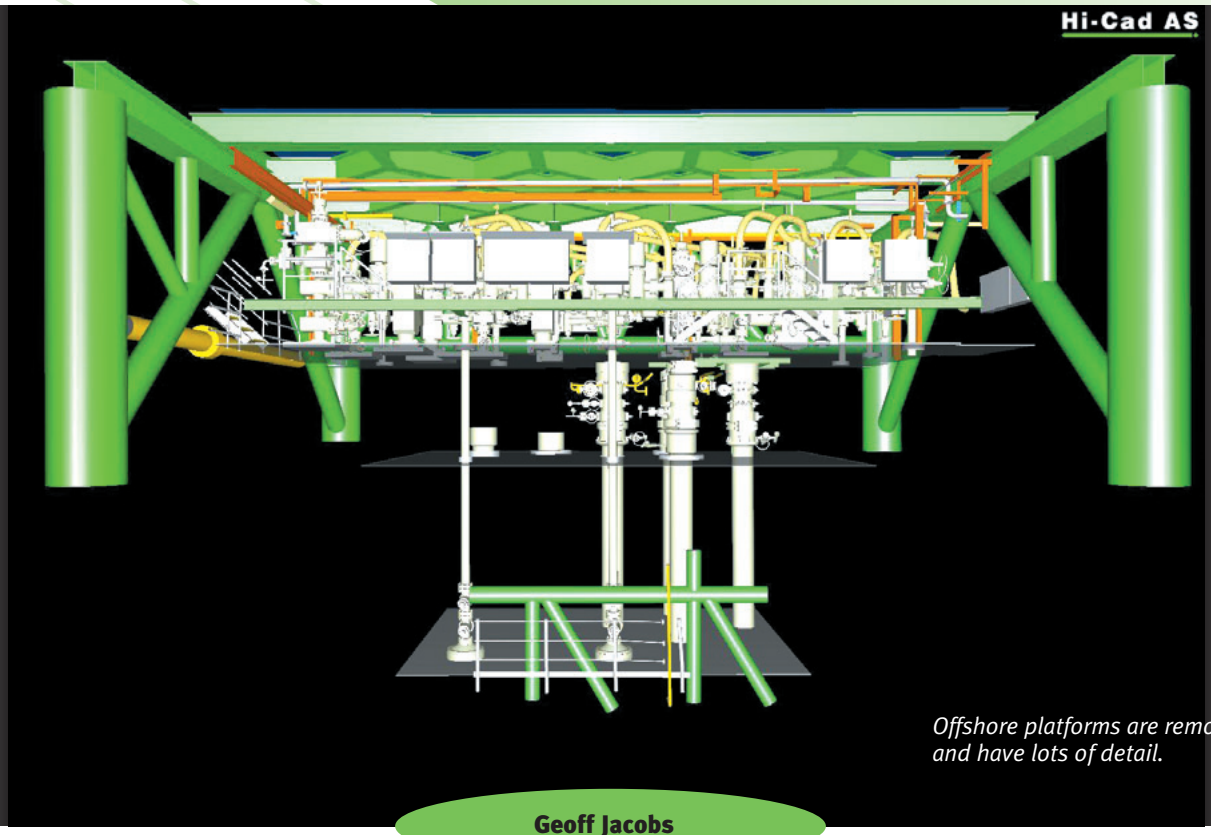
Sites & Structures Part 1



Offshore platforms are remote and have lots of detail.

Geoff Jacobs

In the May 2004 article on high-definition surveying (3D laser scanning), its inherent feature set was described. This feature set was comprised of the following:

- High point density
- Ultra-fast data capture
- Remote, reflectorless measurement
- 3D visualization
- Informative imagery

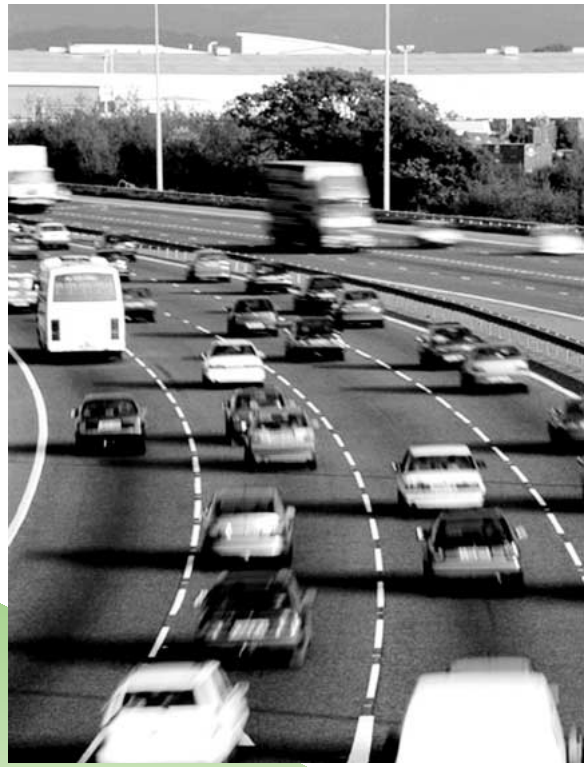
As a combination of these features, a laser scan survey was summarily described as an "ultra-fast, high-definition, reflectorless survey." From a practical and overall economic standpoint, this feature set has proven beneficial over competing measurement alternatives for certain types of sites and structures as well as certain types of projects. Note that a distinction is made here between types of "sites/structures" and types of "projects." "Sites and structures" refer to the physical characteristics (including location) of a site or structure, *e.g.*, a complex, active site that's located "far away" from the survey office. Types of "projects," on the other hand, refer to the business aspects of a project, *e.g.*, a project that may have to be done on a short schedule or a project in which an erroneous survey can have huge economic consequences to a site developer. This article delves into what types of "sites and structures" are the best candidates for laser scan surveys. A subsequent article will delve into types of projects.

Candidate Types of Sites and Structures

The types of sites and/or structures that benefit most from laser scanning are largely ones that can benefit from its high-density data or from its remote measurement, reflectorless capability. Often, sites or structures that take advantage of laser scanning have one or more of the following physical characteristics:

- Complex geometry, surfaces
- Relatively clear of vegetation and/or many stationary visual obstructions
- Lots of detail, congested, tight fits
- Distant location or difficult to access
- Limited in size/area
- Sites that are in active, continuous use
- Hard-to-reach or delicate surfaces
- Unsafe to occupy

Each of these is discussed further below, with examples given.



Busy roadways are active sites that pose safety hazards; they can be laser scanned without lane closures.

Complex Geometry, Surfaces

There are both structural examples and naturally occurring examples of complex surface geometry. Structural examples include large process vessels with multiple flanges, storage tanks with deformations, or the hull of a ship. Laser scanning has been used to analyze the complex geometry of the damage to the U.S.S. *Cole* and the damage to the nightclub in Bali after each was attacked. Likewise, the Statue of Liberty was scanned so that its complex geometry could be accurately replicated should it ever be the victim of a catastrophe. Ornate architectural facades, roof trusses, archaeological sites, and twisting, turning theme park structures are also common subjects for laser scanning. A road or parking surface that's puzzling or a challenging putting green may also have complex surfaces that benefit from a laser scan survey.

Complex natural surfaces, such as exposed terrain and cave interiors, are also candidates for laser scanning. It should be noted, however, that all laser scanners are line-of-sight instruments that measure directly to exposed surfaces. If a laser scanner is set up on a typical tripod, the instrument's line-of-sight to undulating or rough horizontal surfaces is easily obstructed, especially for terrain further from the instrument. Because of this, it is not uncommon to see a laser scanner elevated so that it can look down on horizontal surfaces with a less-obstructed view. Elevating laser scanners on portable platforms can also introduce additional accuracy issues (these will be addressed in subsequent articles). The bottom line is that laser scanners are typically considered very useful for vertical surfaces such as rock faces, mine walls, open pits, landfill piles, dams, tunnel walls, etc., but are more problematic on horizontal surfaces that are undulating or rough unless the scanner can be properly elevated.

Relatively Clear of Vegetation and Stationary Visual Obstructions

If terrain has a dense overgrowth of vegetation, a laser scanner may not have sufficient view of the underlying ground surface to generate an accurate terrain model. For the parking lot referenced above, if there are too many vehicles parked in the lot, the use of laser scanning can be problematic, as the scanner would require many more setups than if the parking lot is essentially empty and the lot can be captured with few setups.

Lots of Detail, Congested, Tight Fits

This is a very common type of geometry that is captured by a high-definition survey (laser scanning): complex piping or mechanical systems. Although the individual elements may have simple geometry (*e.g.,* pipes or steel supports), there are lots of them crammed in a small space and they run every which way. High-density data capture helps ensure that all visible pipes are captured accurately. In general, the more congested and the tighter the fit, the more value that laser scanning brings to the project.

Historically, piping designers/CAD operators have manually measured piping systems with a tape measure and clipboard to create as-builts. Alternately, mechanical designers use original construction drawings as their source of as-built information. Whether they're done manually or based on original construction drawings, such as-builts, they are almost inevitably incomplete and/or inaccurate. Complex piping and mechanical systems can also take advantage of laser scanning's 3D visualization feature, but the use of laser scanning for 2D output is also very common for this application.

Civil projects with lots of detail include municipal intersections in which there are many features (curbs, signs, poles, ramps, traffic structures, lane markings, etc.), bridges and elevated roadways, and rail facilities. Certain types of forensic scenes may also contain a lot of detail and benefit from more complete data capture. Forensic scenes, as noted above, may also contain complex geometry.

Limited in Size and Area

The useful range of laser scanners is generally shorter than many traditional instruments, GPS, or aerial data capture systems. As such, laser scanning projects are often site-specific and unlikely to address hundreds of acres or tens of miles of roadway or pipeline.

Distant Location or Difficult to Access

High-density data capture has proven valuable in reducing or eliminating return visits to a site. Return visits can be prompted by any one of several factors:

- A need to re-check points
- A need to capture something that was inadvertently missed on the first visit
- A change in scope by the client during the project
- An opportunity to provide data from the same site to a different client.

Regardless of the reason, such return visits can be costly if the site is far away.

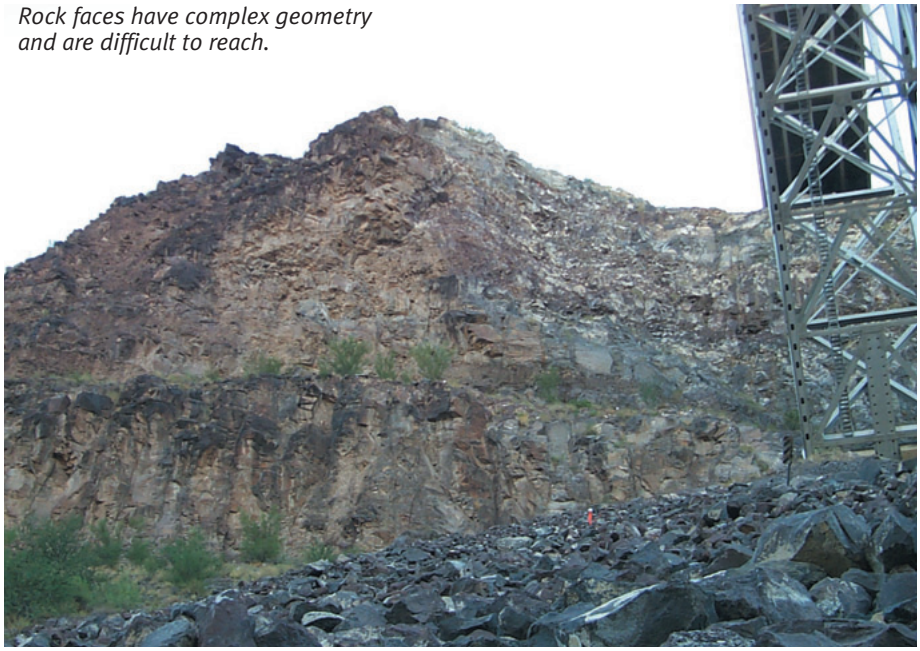
They can also be highly problematic if the site is not always accessible. The more costly or problematic a site re-visit, the better candidate it is for laser scanning. For example, offshore oil rigs are excellent candidates for laser scanning, as are other remote facilities and sites, including remote archaeological digs.

Examples of sites that may not be far away, but may otherwise be "difficult to access" would include rail facilities, tunnels, airports, etc. For security and other reasons, permits are often required to gain access to these types of sites. In some cases, permitting itself can take many weeks or even months, thus delaying the project. So, once a permit or formal access has been secured, there is added value in a high-definition survey that reduces or eliminates any need to return to the site. As a result, rail, tunnel, and airport facilities are common sites in which laser scanning is deployed.

Active Sites

The remote measurement feature and the ultra-fast data capture feature of laser scanning are beneficial when data must be captured while other activities are underway at the site at the same time. Typical examples include live construction sites, operating plants and buildings, active roadways, etc. While some measurement techniques might require a stoppage of the activity (*e.g.*, closing down a lane or roadway), laser scanning can often be used without any impact on the ongoing operation. This benefit alone can represent a large economic gain for a client when comparing laser scanning to other data collection alternatives. Likewise, the ultra-fast data capture rate of laser scanning can reduce the amount of time that a site needs to accommodate data collection. So, even if the site has to make an accommodation for the presence of laser scanning, that impact is often shorter than the impact from using other methods. Movie sets are a good example of this. This is, in fact, one of the appeals of phase-based scanners, as their ultra-high-speed data collection can minimize downtime at certain types of facilities and sites.

Rock faces have complex geometry and are difficult to reach.



Hard-to-Reach or Delicate Surfaces

These types of sites or structures again benefit from laser scanning's remote measurement feature (in fact, from any type of remote measurement method). Examples of hard-to-reach sites and structures include process and power plants, multi-story buildings, vertical terrain (*e.g.*, rock faces), dams, cranes, large storage tanks, overhead lines, bridges, domed ceilings, statues and monuments, stadiums and auditoriums, etc. In many of these examples, alternatives to laser scanning or other remote measurement methods often include the use of scaffolding, climbing or rappelling, or the use of mobile lift platforms. The added cost and safety concerns of such methods can make laser scanning an attractive solution.

Some structures may not be hard to reach, but they may be delicate and the owner's preference may be for the structure not to be physically touched. Examples of this include archaeological and heritage structures, statues and monuments, manufacturing clean rooms, food processing plants and equipment, movie sets, and forensic scenes.

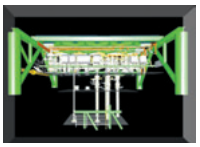
Unsafe to Occupy

These types of sites and structures likewise benefit from remote measurement methods in general. The notion here is that although it may easy to reach all of the surfaces to be measured and they may not be delicate, it may still be otherwise unsafe to occupy them. Examples include old and decaying building interiors, hazardous material waste pits, railways, roadways, airport landing strips, areas of plants or storage facilities with hazardous materials, mines and quarries, active construction sites, etc. There are ways to use traditional methods for these sites, but the added costs and safety risks may make laser scanning an attractive alternative.

Multiple Characteristics

In many cases where high-definition surveying is used, sites and structures feature a combination of one or more of the above site characteristics. In general, the more of these site factors that come into play, the greater the value of laser scanning. Consider, for example, the Buddha statue from the previous article. The statue was carved high on a mountainside. It also featured the following characteristics:

- Complex surface geometry
- Hard-to-reach
- Unsafe to occupy
- Delicate surfaces
- Limited size
- Clear line-of-sight access to the surface



The offshore oil platform example is also one with "multiple checked boxes":

- Lots of detail, congested, tight fits
- Distant location and difficult to access
- Non-intrusiveness is beneficial
- Some parts of the platform may be hard-to-reach
- Some areas of the platform may be hazardous to occupy
- Limited physical size

Summary

Laser scanning can offer cost, schedule, safety, and other advantages for certain types of sites and structures. The characteristics of such sites and structures have been described and examples have been given for civil, plant, architectural/building, and other disciplines. In some cases, sites may have multiple characteristics that combine to make a given site particularly well-suited to take advantage of laser scanning. Site characteristics that are generally not good for laser scanning have also been described. The previous article stated that, in the end, it is the net project cost, the completeness of the data, and the added confidence in the data that are usually the primary sources of project value.

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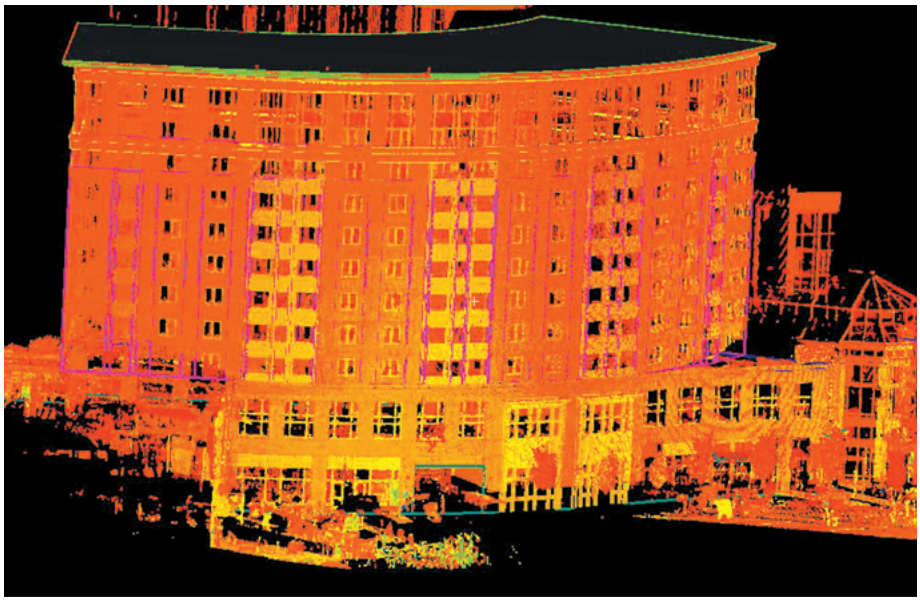

Exteriors of tall buildings with irregular geometry are good candidates.

While the types of sites contribute to an assessment of the merits of deploying laser scanning, "the type of project" also contributes to this assessment. Project types will be covered in Part 2 of this article.

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