TopoLift™ Patented Tripod Technology

TopoLift™ Reinvents the Tripod for Laser Scanning
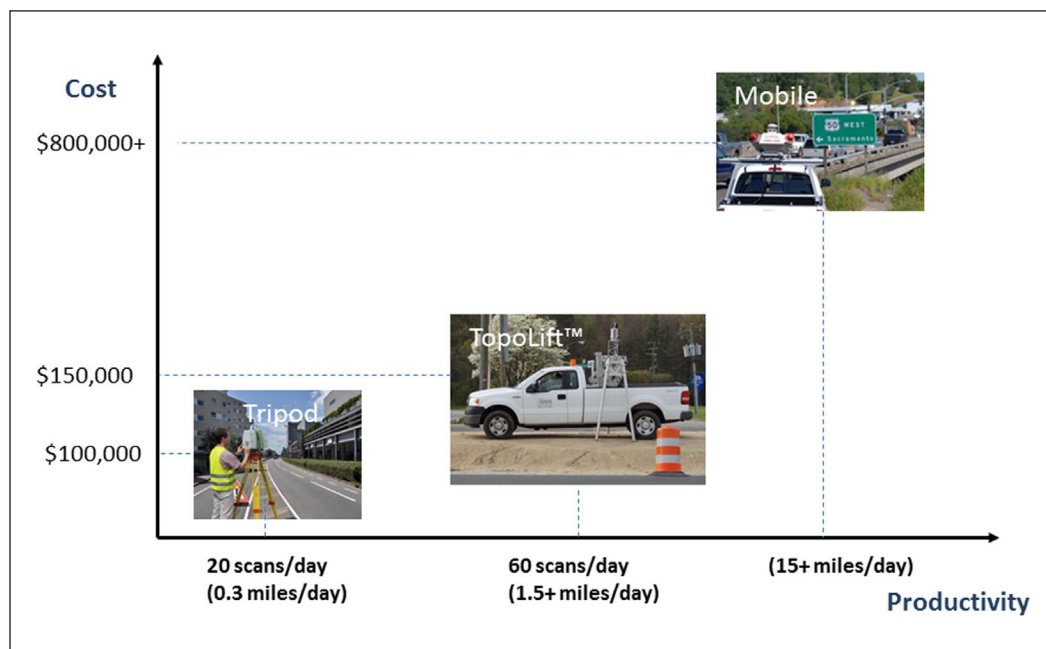
Certainty 3D LLC 's TopoLift™ dramatically raises the field productivity of LiDAR scanning operations

BY TED KNAAK

The development of terrestrial mobile LiDAR systems that can travel at highway speeds represented a huge productivity leap from acquiring data using stationary tripods. As the dust settles within the market, it appears this big step from simple tripod to mobile platform has left a void where neither system quite meets the cost/performance demand of many transportation corridor, campus, complex urban area and similar applications. Such applications are typically characterized as just a few miles in length, or tens of acres in area where there is not a requirement for expensive maintenance of traffic operations, such as full lane closures. Certainty 3D's TopoLift™ , a new innovation in traditional tripod platform technology, is well positioned to meet the requirements of these particular applications.

In these cases both static tripod and mobile operations are often still more costly than traditional survey technology. While tripod laser scanning productivity has increased from about six to twenty scans per day, the operational costs along many roadway applications still exceed that of traditional survey technology. As for mobile systems, the need to amortize

Cost

$800,000+ ········· Mobile

$150,000 ········· TopoLift™

$100,000 ········· Tripod

20 scans/day
(0.3 miles/day)

60 scans/day
(1.5+ miles/day)

(15+ miles/day)

Productivity

TopoLift™ Strongly
Positioned Between Static
and Mobile Platforms
Cost/Productivity

*Cost & Productivity are
estimates based on
application experience

high initial price and on-going support often results in more expensive per mile cost for shorter roadway projects than traditional survey. In addition, mobile LiDAR applications are degraded in areas where GPS availability is limited and/or driving long predictable trajectories is impractical. Thus TopoLift™ is ideally positioned in price and performance between static tripod and terrestrial mobile LiDAR systems along the Cost/Productivity curve.

Stop-and-Go LiDAR Scanning

TopoLift™ platform technology fundamentally implements the "stop-and-go" strategy for LiDAR field operations. In principle, this strategy is no different than traditional tripod operations. The operator transports the equipment to a position, sets up the equipment, sets up reference targets, locates these reference targets, scans the area, assesses results, breaks down the equipment and repeats the process for each scan position.

As illustrated in the following timeline, prior to 2010 most pulsed time-of-flight scanner technology was relatively slow, thereby dominating the timeline. However recent scanner speed increases have reduced the "scan" time to the relatively shortest timeline component. In fact the following illustration makes clear that even further increases in scanner speed will have little effect on overall field productivity. The only way to significantly increase field productivity is to reduce the transport, setup, target acquisition and breakdown times.

As shown above, TopoLIFT™ dramatically decreases those remaining workflow timeline components associated with transport, setup, target acquisition and breakdown. In addition to the reduction in time at each location, TopoLIFT™ increases the effective scanner range on a horizontal road surface by 200% thereby consistently reducing the number of required setups by about 30% for each project. This 30% reduction in required

setups and the 50%+ decrease in time per position yield overall productivity increases of 200-300% over traditional tripod operations.

TopoLift™ 's positive influence on productivity is evident in the reduced timeline discussed above. However TopoLift™ operation has consistently demonstrated additional positive effects on data quality as well. These are:

Point Cloud Fidelity—The increased operational height of the scanner results in much larger incident angles to the surrounding topography surface. This results in generally higher fidelity point cloud data representation of surrounding features.

Data Coverage—The operator employs his laptop in direct communication with the scanner. Thus every acquired point cloud can be immediately assessed for coverage—typically from the top view—and the optimal subsequent setup position selected. The operator can easily identify shadows, sparse data, etc. and
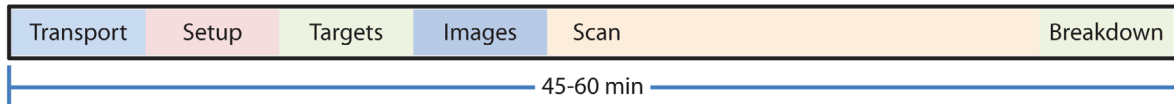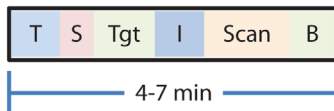
Field Workflow Timelines

optimize the next setup to fill in these areas. This on-site analysis capability assures that TopoLift™ operators do not return with data not meeting project requirements. Note that this is far superior to coverage assessment on a tripod using the small LCD scanner display. These very small screens show the data only from the scanners viewpoint and without data from adjacent scan positions. Often such projects are under-scanned or over-scanned resulting in lower productivity and more expense.

Alignment Accuracy—Quick feedback on least squares fit to surveyed reference targets is immediately available to the operator. The scanner height at 11.5 feet increases availability of reference targets mounted on 8 feet poles as there is a line-of-sight above traffic, landscaping, and other obstacles. This eliminates reliance on level compensation and allows for better resection geometry incorporating targets across a busy roadway or parking lot. Finally, laptop operation facilitates assessing alignment between adjacent

point clouds assuring the data is correct prior to leaving a setup position.

Operator Performance—TopoDOT enhances overall operator performance by eliminating fatigue associated with traditional tripod operation. Constant exposure to weather, constant evaluation of small LCD screens, breakdown, transport and setup results in operator mistakes. A comfortable safe truck cab and a full screen laptop will greatly enhance operator performance thereby avoiding costly oversights, mistakes and other anomalies.

TopoLift™ Field Performance

Certainty 3D's FREE TopoPlanner™ web application is used by hundreds of LiDAR scanning professionals to layout, schedule and estimate cost for stop-and-go laser scanning projects. TopoPlanner™ is also useful to compare performance between different systems and/or technologies.

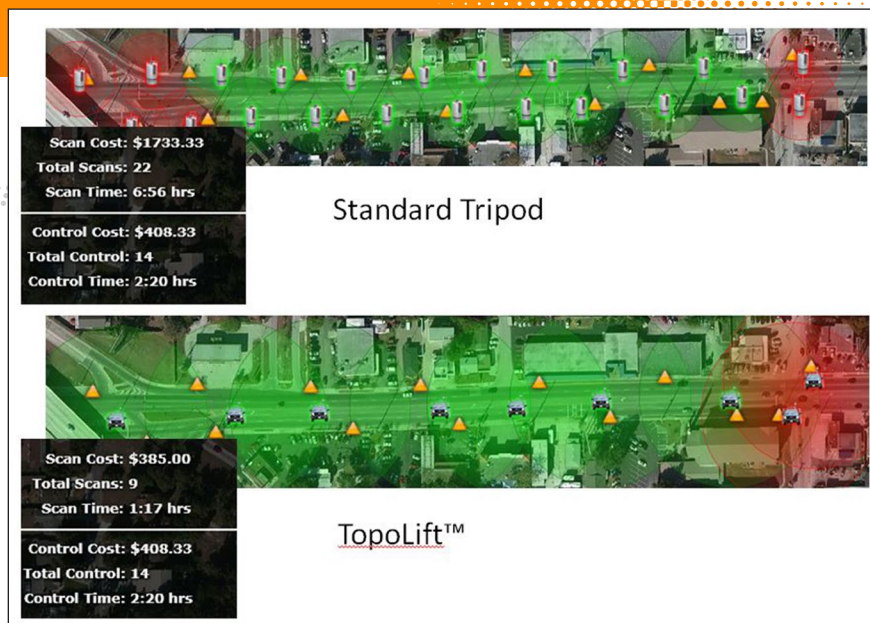Let's begin the discussion of field performance by comparing the "simulated"

field performance of a Riegl VZ400/ Nikon D700 LiDAR system mounted on a standard tripod against the same system mounted on a TopoLift™.

This example shows a 1400 feet (426m) portion of a 1.3 mile TopoLift™ project executed by Southeastern Surveying and Mapping Corporation of Orlando, FL (SSMC). The 1400 feet of urban roadway is illustrated below by TopoPlanner™ screenshots. The transparent green circles indicate scanner effective range down the horizontal roadway surface. This "simulated" tripod project would have required 22 scan setups and 14 survey control reference coordinates. Scan setups would have been required on both sides of the road from the sidewalk. The 22 scan positions would have required 7 hours. Using an hourly rate of $250 would result in a cost exceeding $1700 for just 1400 feet of roadway. Over the entire 1.3 miles, the projected scanning time would have been over 28 hours with cost exceeding $8,300.

TopoPlanner™ Field Performance Comparison

Comparing the standard tripod performance to the TopoLift™ performance reveals significantly increased productivity. Note the larger transparent range circles resulting from increased scanner height. SSMC used the turn-lane in the center of the roadway for each TopoLift™ setup. Each setup only required about 5-7 minutes per position including setting up cones for maintenance of traffic. Thus the actual TopoLift™ project required just 9 setups and less than 1.5 hours to cover the same 1400 feet. At an hourly rate of $300 with the extra $50 covering the TopoLift™ cost, the same distance only cost $385. That is a total savings of 5.5 hours and $1300+ over just 1400 feet. That is a 400%+ increase in productivity!! (Note: The actual 1.3 mile project required just about 10 hours of scanning.)

Project Case Summaries

SSMC's TopoLift™ experience was not isolated to this one project. SSMC is an industry leader in Florida and has used Certainty 3D's TopoLift™ on several projects each consistently yielding outstanding levels of productivity and cost savings. SSMC is not the only TopoLift™ user. Certainty 3D has several TopoLift™ customers around the country. Thus TopoLift™ has been field tested over two years for performance, reliability, safety and overall user acceptance.

Table 1 summarizes just a small sample of the projects performed with TopoLift™ over the last two to three years which are known to Certainty 3D.

Survey and LiDAR scanning professionals will immediately recognize the inherent productivity reflected in these scanning times. Of course the complete project time will include establishing control coordinates prior to scanning operations and post-processing to extract the final model. Establishing a survey control network is project dependent typically requiring between 50% and 150% of the scanning time. Still total field times inclusive of survey control are about 10%-15% that of traditional field survey. This leaves ample time for the 3D model extraction process using programs like TopoDOT®. Complete field-to-deliverable project

schedules are consistently 50% or less than that of traditional survey with cost savings exceeding 30%.

The patented TopoLift™ is innovative and novel as it addresses the tripod, the simplest and most basic component of laser scanning. This insight was born out of long hours in the field combined with the demands of having to earn a profit. The famous business management consultant, Peter F. Drucker, once said, "If you want something new, you have to stop doing something old." It is Certainty 3D's pleasure to offer something new to our colleagues in the laser scanning community. ℹ

Ted Knaak founded Riegl USA in 1993 and in 2011 he founded Certainty 3D, a company focused on data processing software and technology solutions for the laser scanning industry.

Table 1

Project Name	Company	Scan Distance/Area	Time
Downtown Sanford FL	SSMC Orlando, FL	1680 urban road feet	3 hours
Reagan Airport Runway	Bowman Consulting, VA	5200 feet	6 hours
Tavares, FL	SSMC	10 residential miles	10 days
Ybor City, FL	SSMC	2 urban miles	2 days
Campus St. Louis, MO	Certainty 3D LLC	70 acre campus	3 days
Route 60 Richmond, VA	Leading Edge, FL	2.5 urban miles	< 2 days
Winter Park, FL	SSMC	1.3 urban miles	10 hours

These times reflect scanning time only and do not include time to set up control network or 3D model extraction.