Certainty 3D

November 16, 2011

To: General Release

From: Ted Knaak
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Re: Dynamic Workflow Optimization Using TopoDOT™ (#1013)

Introduction

The shift from 2D to 3D CAD has been accelerated by the dramatic increase of LiDAR system productivity these past two years. This information rich data is currently driving requirements for 3D CAD models of increasing complexity.

This document discusses the fundamental motivation for increased model complexity as a consequence of existing predominantly linear workflow models. The significant negative implications associated with increased model complexity are discussed in some detail.

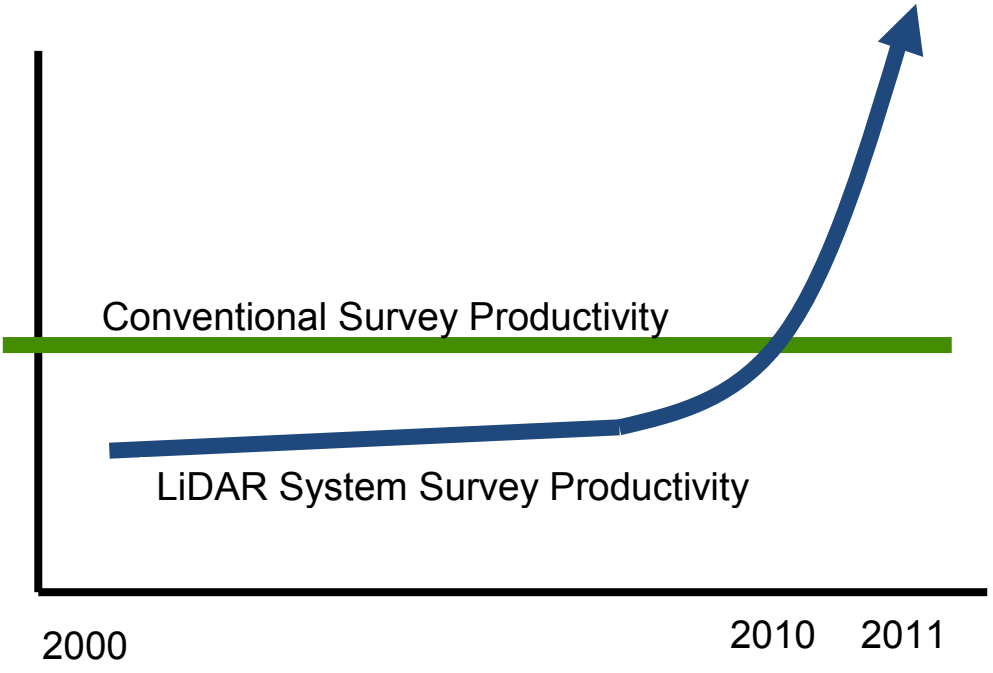
An alternative is offered whereby powerful and low cost CAD applications such as TopoDOT™ can be employed to effectively utilize the system data across all operations. Given this capability the current linear process workflow can be made increasingly dynamic. The result is an extremely optimized process designed to dynamically target 3D modeling requirements at the location and to the extent necessary throughout the process. In addition, this process will tend toward increasing exploitation of the open and standardized system data formats thereby largely avoiding the costs and limitations associated with proprietary nature of complex 3D models.

LiDAR System Productivity

As workstation and software technology has progressed, CAD has long been moving toward a 3D environment. While designers and engineers generally understand the advantages in working in 3D, there are disadvantages associated with 3D which have slowed this progression. Obviously overcoming the legacy of 2D design drawings and associated workflows and processes is difficult. Moreover, 3D does not translate well to 2D computer screens or drawings; thus a disadvantage in cognition and interpretation of

3D must be overcome. However, the primary obstacle to moving toward 3D has been the difficulty, time, and expense involved in acquiring 3D data efficiently.

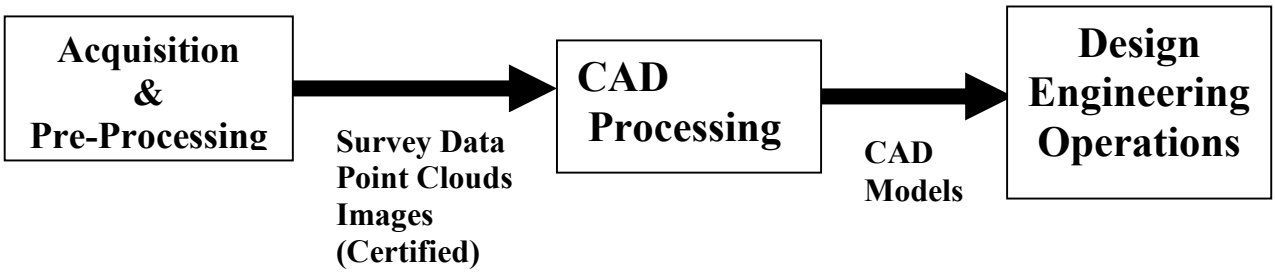
From late 2009 through 2010, the introduction of highly efficient LiDAR survey systems capable of acquiring large amounts of 3D spatial data efficiently and quickly has brought down acquisition expense dramatically. These new systems have fundamentally changed the economics of the process such that the move to 3D CAD across operations is accelerating greatly.



Practical Implications of Complex 3D CAD Modeling Requirements

As a consequence of this dramatic increase in field productivity, there is a general push within the survey/mapping community to define 3D CAD standards. Typically these standards require the extraction and development of very detailed 3D models. Such models are intended to provide the downstream engineering, design and construction operations a more comprehensive understanding of the project environment. ***While well-intentioned, these detailed 3D CAD models requirements may very well prove counterproductive, inefficient and uneconomical.***

Typically these requirements have been developed based on the "current" understanding of how downstream operations interact within their CAD environment. Whether civil transportation infrastructure, architecture, facility or similar applications, engineers and designers (downstream operations) practically always work on models extracted from field data and passed on to them. The process is rather linear. Clearly in this process model, CAD processing lies directly in the critical path. **Thus increased modeling requirements will directly increase project time and cost.**



Within the context of these current workflows, the logic for more detailed and complex 3D CAD modeling requirements is understandable*. If there is now so much more acquired 3D data, then more complex and detailed models must be necessary to capture the inherent information within this data.*

However this movement toward 3D models of increased complexity over entire projects will in all probability prove sufficiently counterproductive as to negate much of the process efficiencies gained by front end acquisition systems. Consider the following:

3D Modeling is relatively labor and time intensive – The ultimate process outcome of LiDAR system technology and downstream workflows is to shift activity from the field to the office. As stated previously the dramatic increase in system productivity reduces field time by several hundred percent, thereby allowing more time for the necessary office processing. Depending on the productivity of the system, the ratios of office to field personnel will increase dramatically as illustrated below.

Survey Field Crew to CAD Tech Ratios

3:1

CONVENTIONAL

$1:6^{+}$

LASER SCANNING

This increase in the ratio of office to field personnel is necessary and unavoidable. Note that the entire process *still yields dramatic efficiency increases over conventional workflows.* However it becomes obvious that data processing will become the "relative" bottleneck in the workflow**.** ***It therefore stands to reason that extraordinary requirements for detailed 3D models will be a major contributor to process cost.***

3D Modeling Always Loses Information – Modeling, by definition, is a "representation" of the information inherent within the raw data. Information to some extent is always lost in the modeling process. One might foresee that the reality of budgets and schedules will inevitably restrict available modeling time. ***Therefore, by definition, models passed downstream to engineering and design operations will not represent "all" the information contained in the data.***

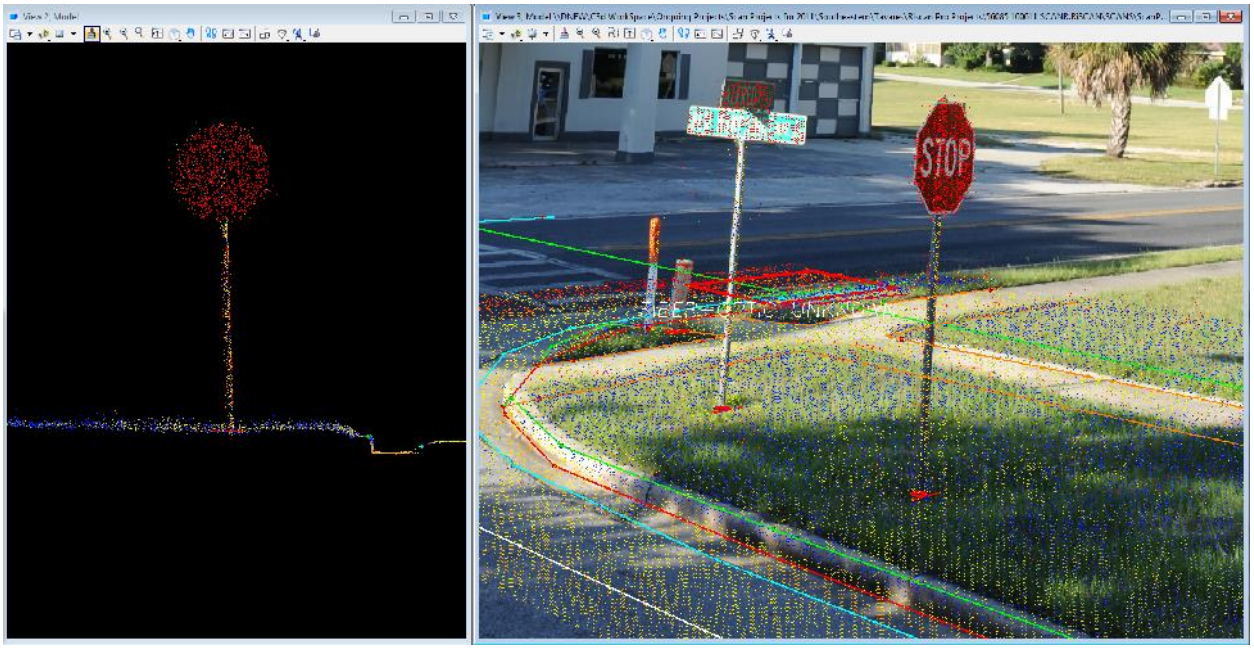
3D Modeling Requirements Vary Across Project – Detailed modeling requirements are typically not required over an entire project. A hypothetical retrospective analysis of most projects might find that 3D model requirements could have been relaxed by say 40% or so. The problem in achieving any such modeling efficiencies is that within the context of the current linear workflows it would be practically impossible to predict where, when and to what extent modeling requirements might be relaxed in a project. Furthermore different downstream operations will place different requirements on the model. **Consequently, 3D model requirements are then driven by the most extreme downstream requirements and applied across the entire project.**

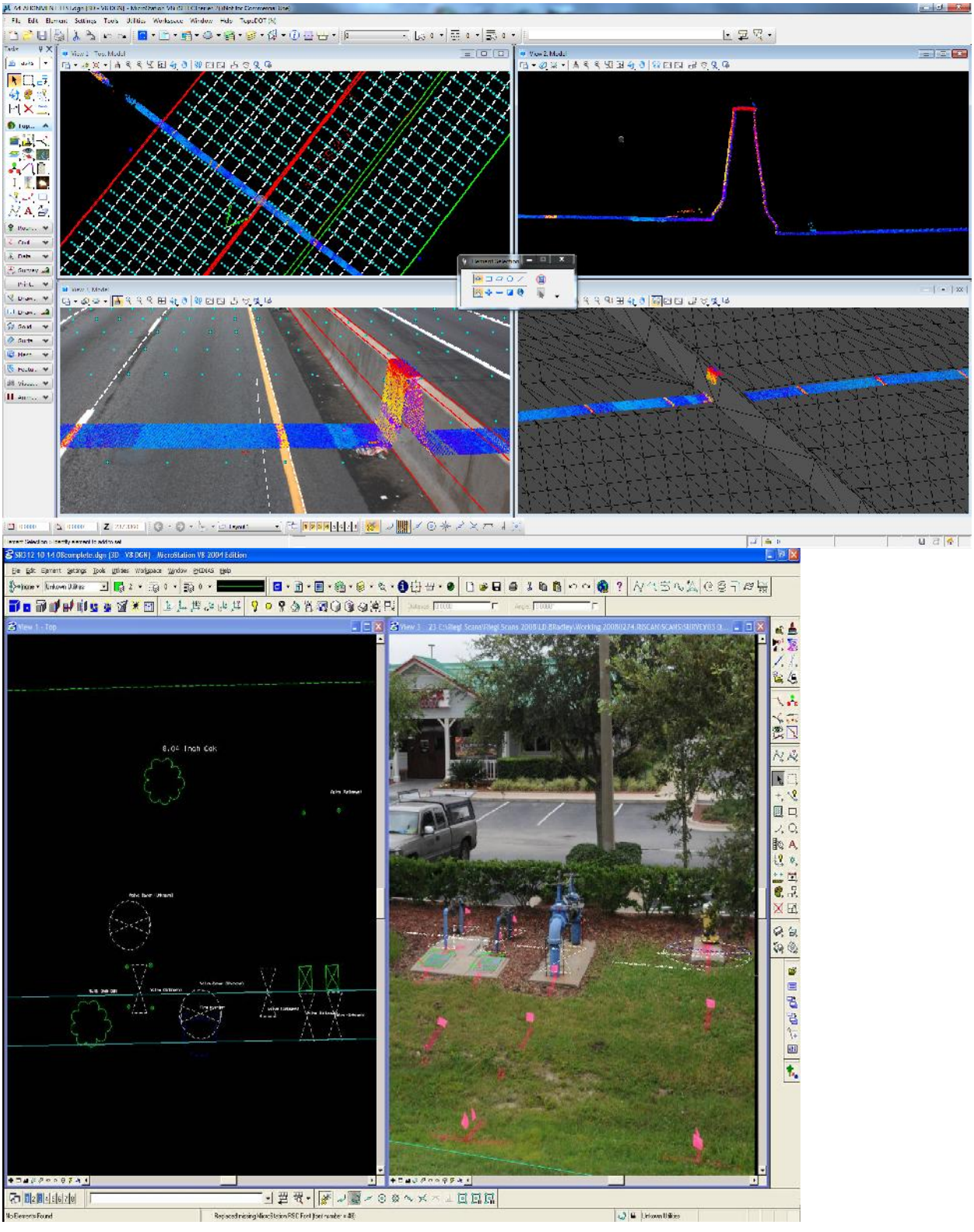
3D CAD Models Are Typically Not Open Source – As a general rule, the more complex the 3D CAD model, the less easily it can be transferred between CAD platforms. While most CAD platforms support common model formats for basic models, lines, etc. more complex models become increasingly proprietary. Thus any strong move toward 3D CAD models of high complexity places serves to restrict the user to a vertical single source solution to their CAD design environment. **This restriction to a single vendor/platform generally adds long term expense throughout every level of CAD operations.**

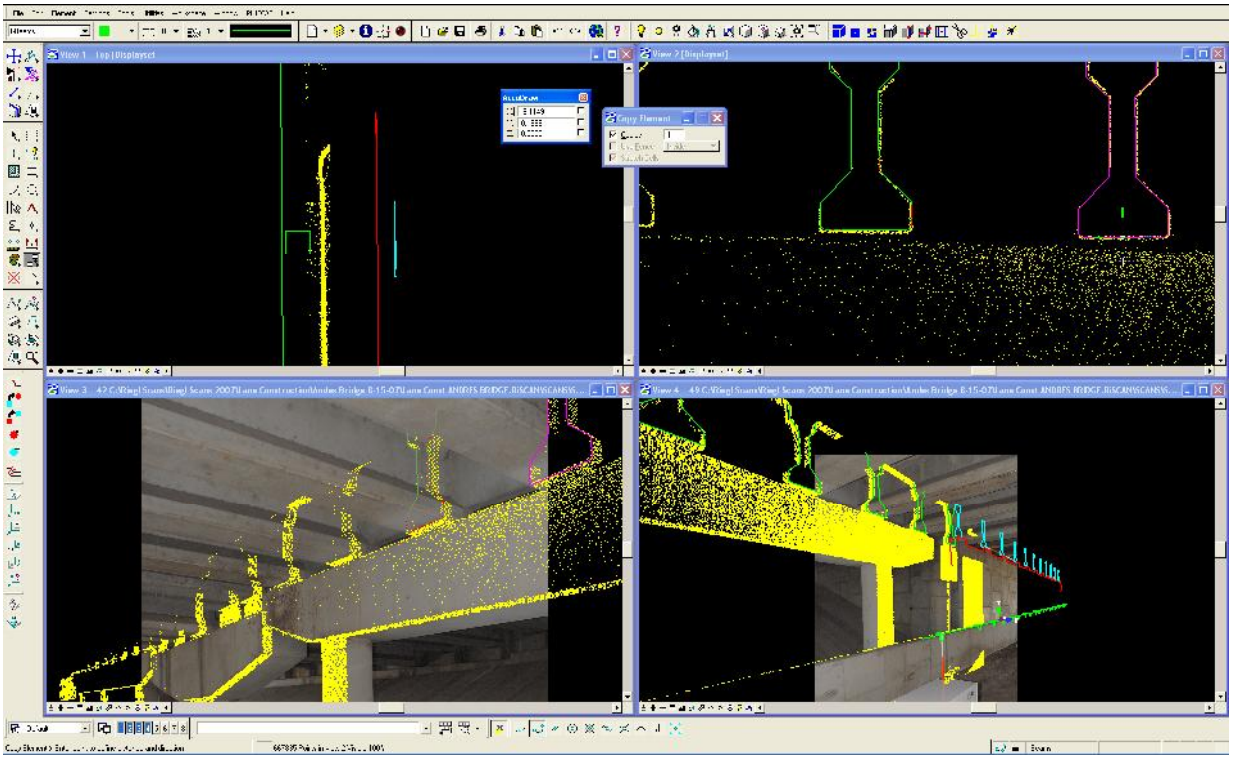
Optimizing the 3D Modeling Process

In the following discussion, the positive implications of allowing the raw 3D data to flow directly to downstream operations are demonstrated. Specifically overcoming the negatives associated with complex 3D modeling are discussed.

Recent developments in high performance processing applications within a CAD platform greatly facilitate the use of raw point cloud and calibrated image data across all downstream operations. User-friendly and inexpensive applications such as TopoDOT™ present users with point cloud and calibrated image data in a very user-friendly, intuitive and useable format for measurement and feature extraction. Some examples are shown below.

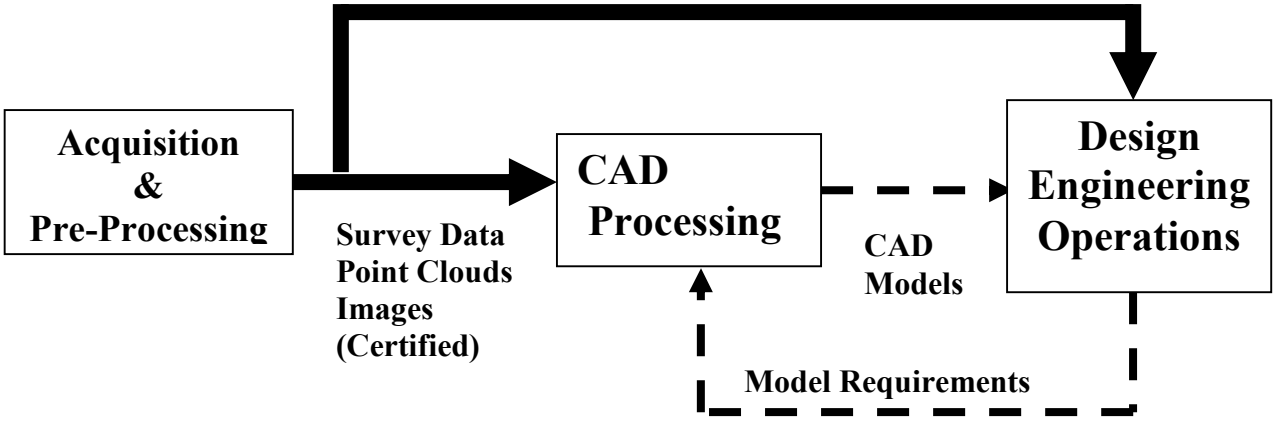






Applications such as TopoDOT™ provide the opportunity to rethink the very linear workflow described in the previous section. Allowing certified data to flow directly to downstream operations can effect a significantly more dynamic CAD modeling process.

In the revised workflow below, data is made immediately available to CAD processing and downstream operations. Initial 3D modeling requirements within the CAD Processing operation can be simplified thereby reduced in scope, cost and time. Given the rich data set provided directly to downstream operations, initial assessments, measurements, comparisons to design elements, etc. can be undertaken immediately. Based on these assessments the engineering/design operations can offer direct feedback as to the location, area, complexity and priority of the 3D modeling requirements as they are needed.



Let us revisit the specifics of the previous discussion to demonstrate how this modified workflow will potentially dramatically overcome the negative implications of an extensive increase in 3D modeling requirements.

3D modeling labor and time are greatly reduced – Applications such as TopoDOT™ which provide downstream operations direct access to the data and greatly facilitating measurements, existing condition assessments, and simple feature extraction at desired locations, will greatly minimize the complexity of the initial 3D modeling requirements at the CAD Processing operation. There is the added benefit of an overall accelerated schedule as the downstream processes can start project assessment immediately without the significant delay associated CAD Processing. **This will consequently greatly reduce manpower, time and cost of the initial CAD Processing operations.**

There is no loss of information – Providing downstream operations direct access to the original data with the means of interpreting and extracting information quite simply means information inherent in the data is not lost in a modeling process.

3D Modeling Requirements Are Optimized – The very positive outcome of early use of data in downstream operations is the requirements feedback to CAD Processing operations tailored to overall project requirements. The "one-size-fits-all" requirements are effectively replaced with a dynamic process focusing CAD Processing operations optimally where and when they are needed. **This dynamic requirements process will eliminate much of the waste in time, manpower and schedule necessary to create complex 3D models across the project.**

Open Source and Multiple Platforms are Facilitated – Point cloud data, survey data and calibrated images can be easily imported and transferred across any platform as standard open source formats for these data types have long been established. By shifting emphasis away from complex 3D models and towards this data, the negatives in cost and restricted platform options associated with proprietary model formats are to a great extent avoided.

Conclusions and Recommendations

The advent of highly productive LiDAR systems has accelerated the push towards increasingly complex 3D model design requirements in CAD. Such requirements can potentially impose very significant funding, schedule and manpower costs on organizations taking a "one-size-fits-all" approach to these models. These requirements are the logical consequence of the very linear process model associated with current field to CAD deliverable operations.

This document demonstrates briefly the extremely information rich nature of LiDAR system data. The availability of CAD applications such as TopoDOT™ empowers the user to extract and exploit the inherent information contained within the data in an

intuitive and user-friendly CAD environment. This capability motivates a restructuring of the overall process workflow in such a way that the entire process is dynamically optimized throughout the project. The positive implications for cost, schedule and manpower requirements are significant.

Any organization would be well served to investigate and understand the extent to which applications such as TopoDOT™ can be used to directly extract useful information from LiDAR data sets without any complex 3D modeling requirements. A small focused team emulating the dynamic processes described herein should be established within the organization. This team should be assigned to several projects until quantifiable metrics for return on investment can be established. Expanding the model appropriately throughout the organization can follow.

Questions and/or Comments

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