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Engineering an Easier Way

WHITE PAPER:

FOREST ROAD DESIGN IN FLAT TERRAIN

By using road design software in conjunction with LiDAR, planners can reduce the time required to plan their upcoming road projects, reduce uncertainty in their plan, choose better road locations, and see many additional planning and operational benefits.

Introduction

Forest roads are an essential part of forest harvesting operations. Their location and construction have significant impacts on harvest efficiency, operational costs and on environmental impact.

In flatter terrain, the forestry sector has been reluctant to complete geometric road designs (alignments, cross sections etc.), where survey collection and design cost have been perceived to be more expensive than the benefits.

In this white paper, we explore the benefits of geometric forest road design in flat terrain, specifically as LiDAR data becomes more readily available.

Historic Reluctance to Design Roads in Flat Terrain

Common practice in flat terrain has relied on GIS-based planning of routes, extensive field review, field marking and mapping. In recent years, the availability of low-cost, high-quality topographic data has created opportunities for planners to improve road location, improve estimation, lower construction costs, reduce field time and create contract documentation.

Previous reluctance to make full road designs a standard practice was justified due to the extra cost and time required to hand-collect survey data, as well as the limited accuracy of that data. But, with the increasing availability of LiDAR, this reluctance is changing.

Figure 1 – Common practice in flat terrain has relied on mapping.

The Power of LiDAR

By incorporating LiDAR into the road planning workflow, organizations can reap many rewards over the traditional approach. Designers can use LiDAR data in conjunction with road design software to reduce the time required to plan their upcoming projects, reduce uncertainty in their plans, and choose better road locations.

Leveraging LiDAR and road design software leads to:

- reduced uncertainty for project scope,
- reduced planner and builder indecisiveness,
- better route locations,
- improved estimating,
- improved communication,
- improved project documentation, and
- improved road safety and reliability.

Improved Workflows

Road design software, by its nature, provides the opportunity to improve planning workflows, including improved estimation, reduced planning time, and reduced uncertainty.

Using traditional methods, preliminary desktop assessments are coarse and qualitative, and the proposed road is usually considered as a line, rather than a 3-dimensional surface. As a result, the proposed alignment often requires considerable field review and adjustment to meet operational requirements.

Road design software, such as RoadEng Forest Engineer *(shown in Figure 2 below)*, presents the spatial data and proposed road as 3D surfaces. Planners can view their proposed road and see:

- the vertical and horizontal alignments and how they interact with the surrounding terrain,
- the cross-section geometry and how it interacts with the surrounding terrain, and
- the geometry and placement of culverts and how they interact with the road's geometry and surrounding terrain.

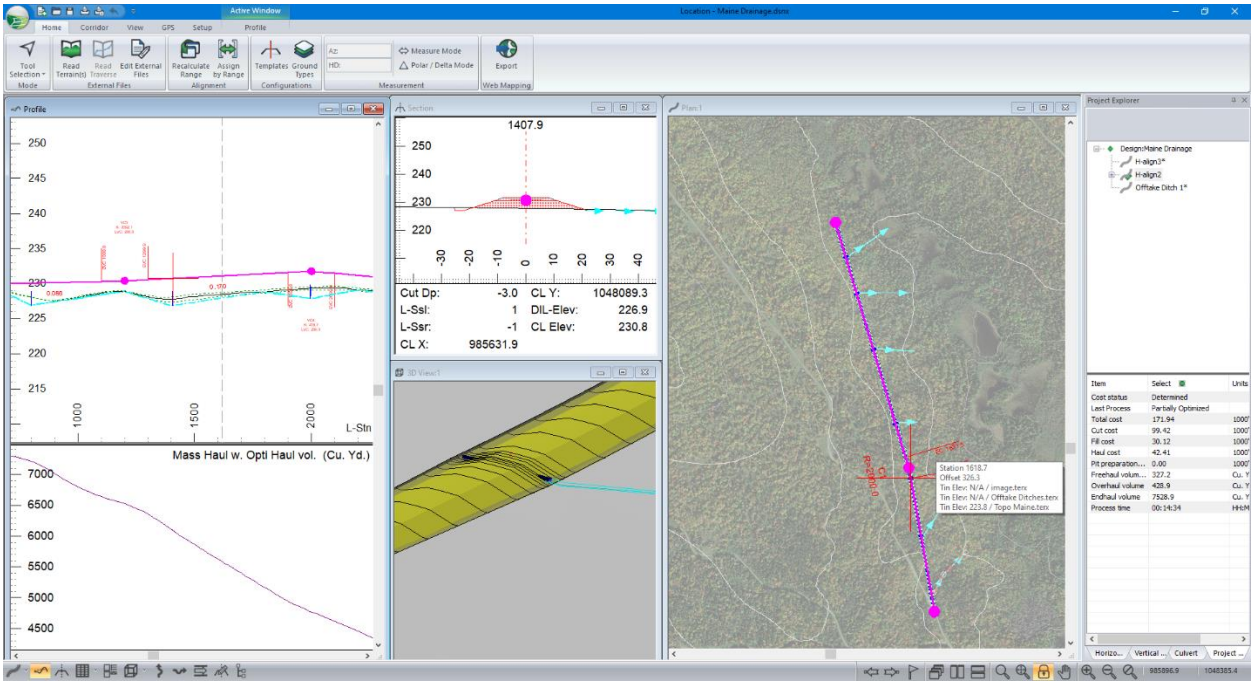

Figure 2 – Spatial data presented in RoadEng' s four typical windows: profile, section, 3D, and plan. Road Costing data is shown in the Project Explorer panel.

RoadEng is interactive. A planner can make design adjustments and see the impact of the change instantaneously. Tabular data, including material take-off estimates, mass haul data, culvert specifications, coordinates, clearing areas, and construction costs, can be viewed and updated in real-time as the planner explores various options. Having this information in one place allows planners to make better decisions in less time, avoid indecisiveness, reduce uncertainty, and evaluate road options by using quantitative metrics.

Quantifiable Metrics and Improved Estimation

Transitioning from assessing and communicating road plans using qualitative terms to quantitative terms has several benefits.

From a communication perspective, using quantitative data avoids ambiguity and inconsistency that can cause problems for scheduling and bidding.

From a planning/estimating perspective, using quantitative data allows planners to make informed decisions around the cost drivers for their road construction, including how much material is being handled and how far it is being moved. RoadEng will continuously keep track of expected earthworks volumes, material movement, and automatically calculate expected construction costs. These costing values can be customized to reflect user's in-house data or values based on published data.

Road design software can help planners and builders better account for other project complexities and requirements. These items include:

- Allowing planners to set realistic production targets for builders based on material handling and movement requirements,
- Improved scheduling by basing production expectations on material handling and movement requirements (rather than per linear unit of road construction),
- Improved material take-off estimates by including aggregate, textiles, and culvert requirements.

Improved Road Safety and Reliability

RoadEng software allows planners to improve road safety and reliability. This is done in two ways:

First, users can customize road prism dimensions, add components, and adjust alignments so they can capture geotechnical, drainage, and safety specifications.

Second, road design standards specify minimum curve values for various design speeds. By adhering to these standards in their road designs, planners can ensure changes in road direction, through horizontal and vertical curves, are safely designed.

Communication

The benefits introduced so far have focused on allowing planners to design their road more efficiently and effectively. Without a means to communicate the road design to a builder, design benefits are limited.

Creating formatted construction output sheets is easy, fast, and highly customizable using the Multi-Plot function of RoadEng. This function gives planners the information required to control the implementation of their design as much they would like.

In some instances, planners may decide to only give builders verbal instructions for basic road upgrades, such as ditching and surfacing, but use road design software to quantify the requirements.

More commonly, planners use the software to issue conventional drawings that reference field markings (*similar to Figure 3*).

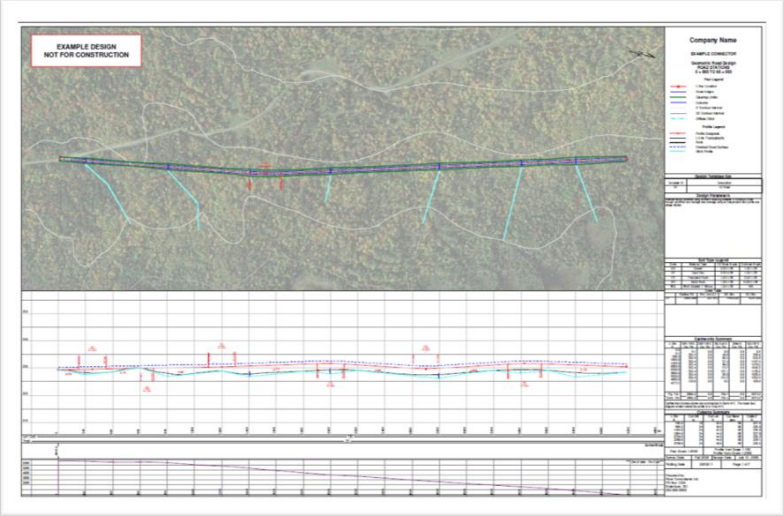

Figure 3 – Typical Multi-Plot output created through RoadEng.

Planners can also issue GPS-compatible drawings for builders to follow the design with the aid of a GPS. Full drawing sets and digital staking information could also be used, so builders can leverage machine controls to help ensure the road is built exactly to plan. Regardless of planners' preference or project needs the software has the power and flexibility to handle the outputs they require.

Design output sheets provide clear documentation, communicating plans, quantities, and expectations for a project. Providing these documents to builders helps to eliminate builder uncertainty and reduces downtime for questions and indecisiveness. This helps increase productivity and reduces the likelihood the road will be under or over built.

If the road is not built as planned, the design documentation can also be used as a record to settle construction discrepancies.

Conclusion

Using road design software, such as RoadEng, to plan resource roads has many benefits, but there has been a historic reluctance to use this technology in flatter terrain, when planners had to rely on conventional survey data. The availability of LiDAR data has made this reluctance unjustified. By using road design software in conjunction with LiDAR, planners can reduce the time required to plan their upcoming road projects, reduce uncertainty in their plan, choose better road locations, and communicate those plans more effectively to the road builders.