BIM Based Paving by LiDAR
An Example Case from Finland
Hannu Korpela

By courtesy of Mr. Markku Pienimäki
from Finnmap Infra
About Terrasolid

- Founded in 1989, based in Finland
- 20+ years of software development for infra design
- 15+ years of point cloud software development
- Customers in 50+ countries
- Global market leader in processing airborne and mobile laser scanned point clouds (*TerraScan*, *TerraModeler*..)
- Customers: national land surveys, mapping operators, engineering companies, municipalities..
- Final products: ground height models, orthophotos, 3D-city models.
- Solutions for mapping and cadasters, infra design, transmission line surveying, forest inventory, housing and environment monitoring, flooding prevention
Determination of paving costs

The traditional costs fixing dilemma in construction process:

- Possibilities to affect costs and results are mainly fixed at early phases in a project.
- Costs (for changes) are formed during construction.

Costs in paving project:

- Paving is essential in road maintenance.
- Paving is expensive action in maintenance.
- Traditionally paving is rather poorly designed.
- BIM is good tool to make changes in traditional process.
"BIM-based paving" method

Road Construction

- Construction
- Measuring the milling
- As-planned model / machine guidance model
- Design model
- BIM-based design
- As-built model
- Comparisons / Quality control

Analizing the Road

- Structure measurements
- Road condition measurements
- Asphalt tests
- Registry data of road
- Structure model

Processing scanned data

Classified point cloud

Design data & drawings

Initial data model

Surface

Basement

BIM-based paving

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Mobile laser scanning

Measurement

- Mobile laser scanning (land mobile mapping)
- Several devices and types (e.g. Trimble, Riegl, Lynx…)
- Absolute and relative methods
  - absolute (global) – global coordinate reference signal points → automated machine control system
  - relative – in relation to the existing surface → "assisted" machine control system

Processing the mobile scanning data

- Raw point cloud after measurement
- Classifying the points
- Matching several measurements
- Searching and digitalizing road lines

→ Road surface model
Road basement structure conditions

Measurements

GPR, FWD / TSD

Common coordinate system for all data

- global is best but well-defined and clearly marked local system is sufficient
- To check measurement results some core samples are needed
- Old, design drawings and historical information of road maintenance tasks would be valuable.

Handling the results

- The "bottom surface" of asphalt layers are designed/ modeled by using some margin of certainty
- As a result there are surface models of asphalt layers (all layers in the structure)
- Layer surface models are used as initial data for BIM modelling and to check the possibilities to realize the BIM designed actions
Analizing the surface conditions

Graphical views
Analyzing the prevailing condition

Calculating the critical values in road section

Cross slope (regression line)

Maximum rut depth

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BIM-based design

Software
- Bentley InRoads, Microstation (PowerCivil)
- Terrasolid TerraScan

Process
- Digitalizing horizontal geometry (border lines, middle line)
- Designing vertical geometry (according InRoads / Excel regression analysis)
- Designing cross slopes
- Combining geometry designs and iterating the solution
TerraScan Component Fitting

From a survey vector
- Road features (e.g. center line)
- Rails
- Vehicle trajectory
- ....

to geometry components for design software e.g. with LandXML
Example Design (Sito Engineering / Trimble)

- VT6 road improvement – length 22 km
- Starting point – valid surface
- Each road component were adjusted one by one to get an optimised solution (mill and fill)
- Follow standards of road geometry
- Deliveries to construction phase: breaklines, visualised 3D models, cross sections
Volume Calculation
Surface sloping in cross sections

Large variations in side slopes

'Boat bottom'

Flattened boat bottom

Large side slope/ depressions

Distance/station (m)

Right side

S1 MLS survey  After standard  As designed

S2 MLS survey  After standard  As designed

Left side
Monitoring the design

![Graph showing overlay adjustment and section fill area](image-url)
Asphalt works

Lähde: Manu Marttinen, NCC Roads
Work monitoring by comparing original versus 'as-build' / side slope

The renovation improved the quality and the safety of the road remarkable
Demonstration video
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Many thanks for Your interest

hannu.korpela@terrasolid.fi
www.terrasolid.com
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