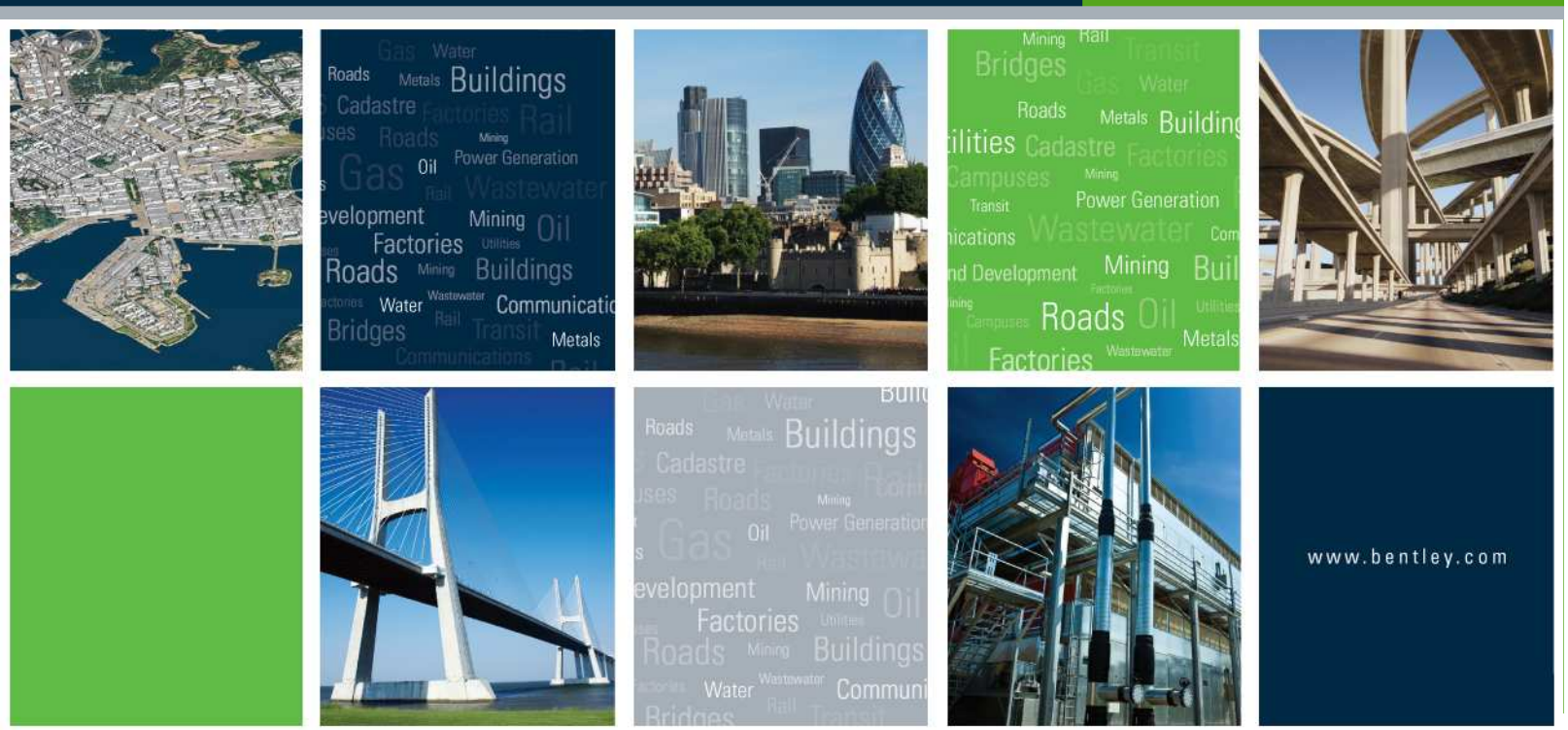


Bentley Rail Track

An introduction

Bentley
Sustaining Infrastructure

Solution Overview

- Suitable for every type of railway
  - Heavy freight and passenger
  - High Speed
  - LRT, Metro, Tram
  - Maglev
- Suitable for every stage of the asset:
- Feasibility / preliminary route evaluation
- Detailed design of new projects
- Detailed design of renewal / upgrade projects
- Multiple international design standards

Solution Overview (continued...)

- Inbuilt design checker for designer and client
- User configurable for
  - Design standards
  - Turnouts
  - Drawings
  - Reports
- Multiple languages
- Highly interactive and easy to use

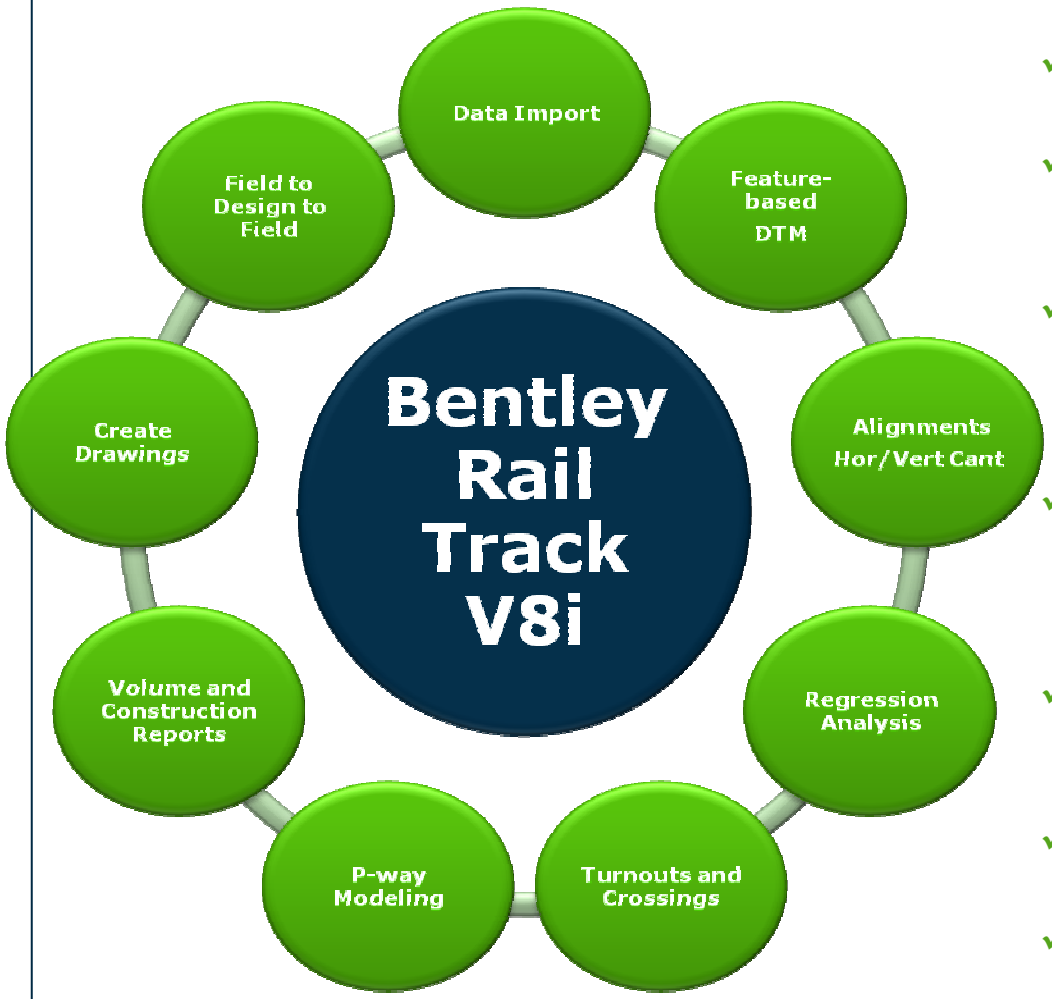
System Functionality

- Comprehensive surface analysis
- Horizontal and vertical alignment design
- Cant and cant deficiency design
- Design check against standards
- Single and multi-element regression analysis
- Automated turnout placement using library
- Ballast, formation and earthworks design and analysis

System Functionality

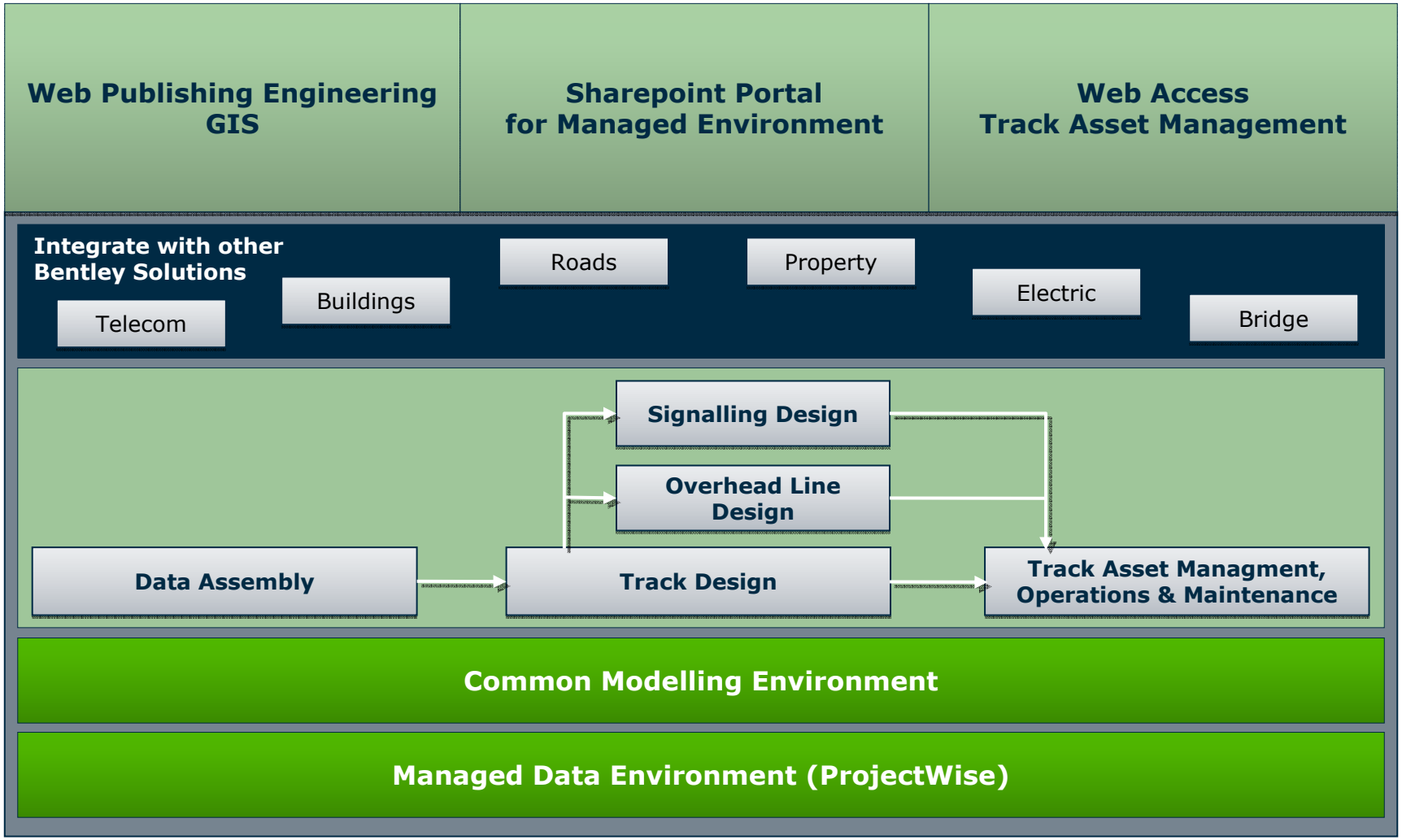
- User defined outputs
  - Drawings
  - Reports and schedules
  - Manufacturing details
- Data export
  - Machines - Plasser & Theurer and Matisa
  - Field computers
  - Manufacturing
- Industry standard data (eg: DGN, DWG, XML)

Bentley Rail Track



- ✓ A global rail design software
- ✓ Automates design workflows for every kind of rail projects
- ✓ Supports new and upgrade projects for single or multiple tracks
- ✓ Standardizes project outputs – drawings, volumes, construction reports etc..
- ✓ Enables design checking and validation
- ✓ Design to field interface
- ✓ Integrates with Bentley Overhead Line for traction power design

Solution Architecture



Data Import and Analysis (Survey)

- EDM (Total Station)
- Aerial
- Trolley
- GPS
- Volume scanning

Bentley

Data Import Tools

- LandXML
  - Geometry and surface models
- Vendor Specific
  - Trimble Upload Add In
    - Geometry and surface models
  - Lieca Upload Add In
    - Geometry and surface models
  - Geometric Measurement systems
    - Plasser & Theurer (EM-SAT)

Field to Design

- Reading data from Plasser & Theurer's EM-SAT geometry measurement system
  - Advanced long chord measuring resolved to real world coordinates!

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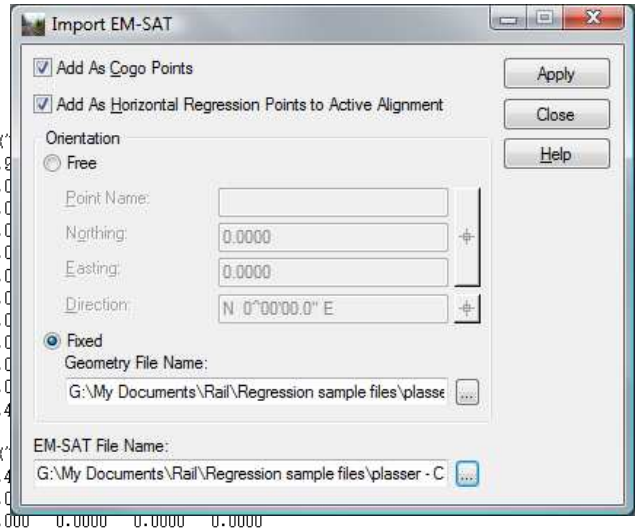
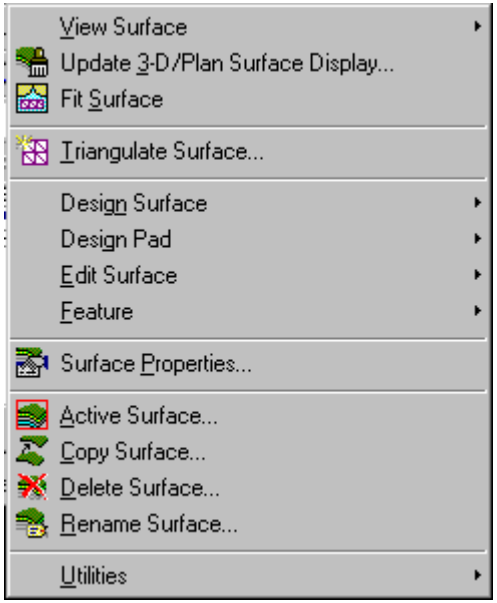


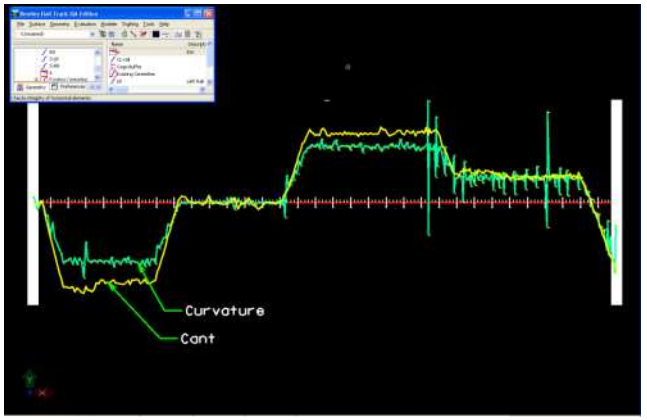
Bentley

Surface Analysis

- Load survey data
- Display and view surfaces as contours, triangles, feature lines
- Shade according to aspects, elevations and slopes
- Triangulate surfaces
- Design and edit surfaces



Regression Workflow…

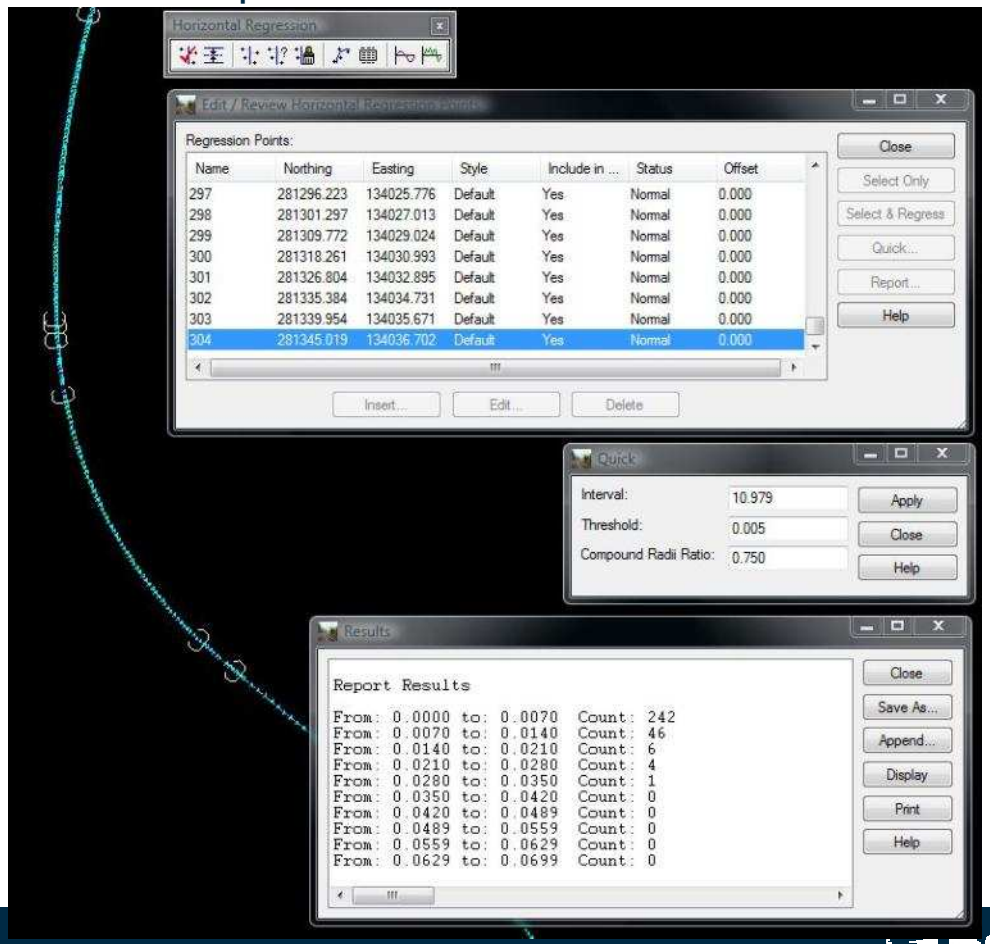


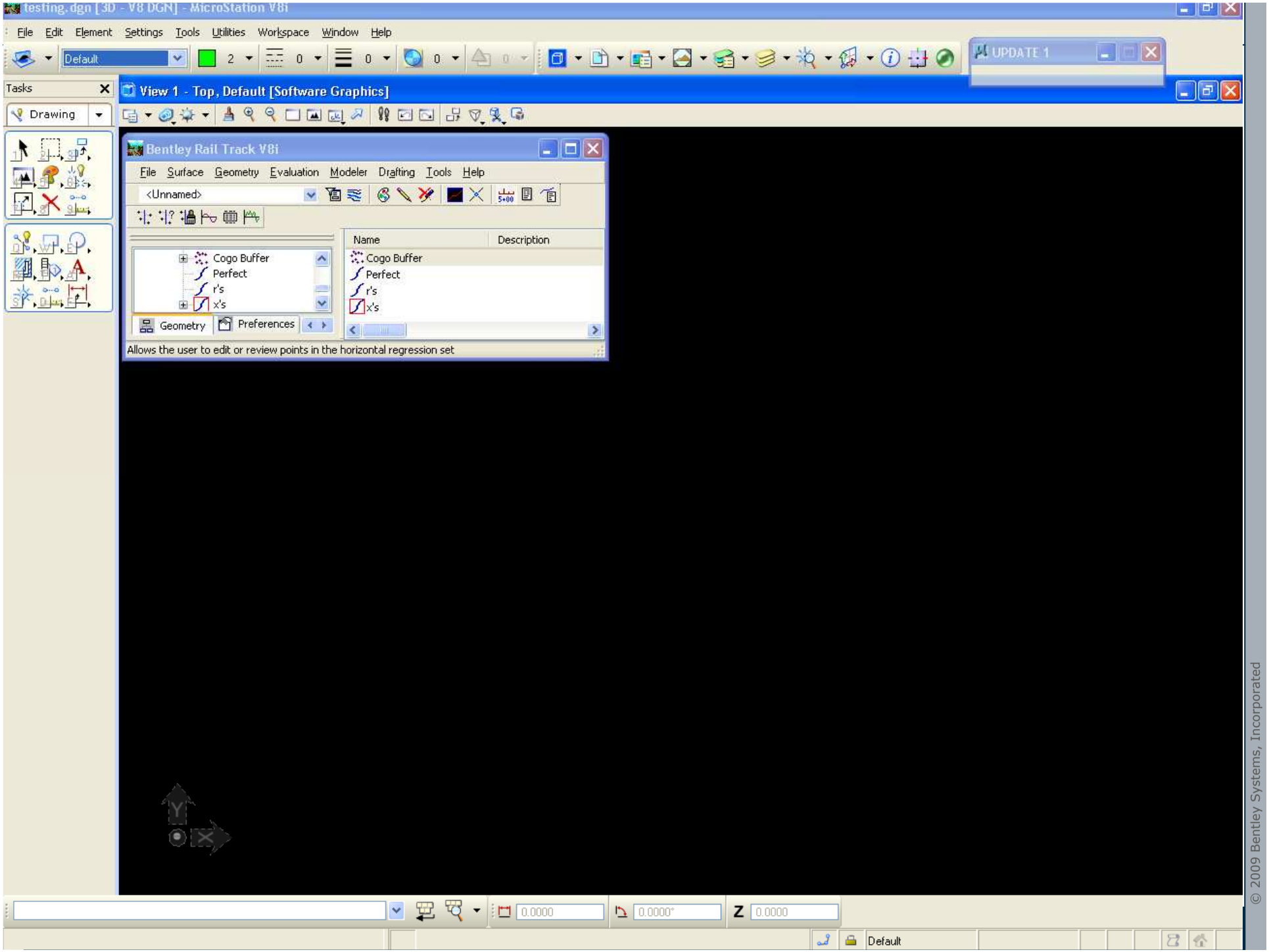
- Pre-regression data validation
- Point selection and sorting
  - Survey data ordering is not required
- Curvature diagrams
  - Indicates approximate locations of specific elements and their types
  - Indicates questionable data
  - Inclusion of cant, if surveyed, enhances the field data
- Edit / review
  - Select / Regress, which is heads-up selection / auto element type determination
    - Reduces potential user errors & time
- Quick Regression for initial solution
- Slew diagrams and reporting

Quick Regression

New in 'V8i'

- A *first* pass horizontal regression solution
  - Excludes the possible location of transitions
  - Computes either a *linear* or a *circular arc*
  - Fills in the gaps with transition spirals





BRT - a true rail design system

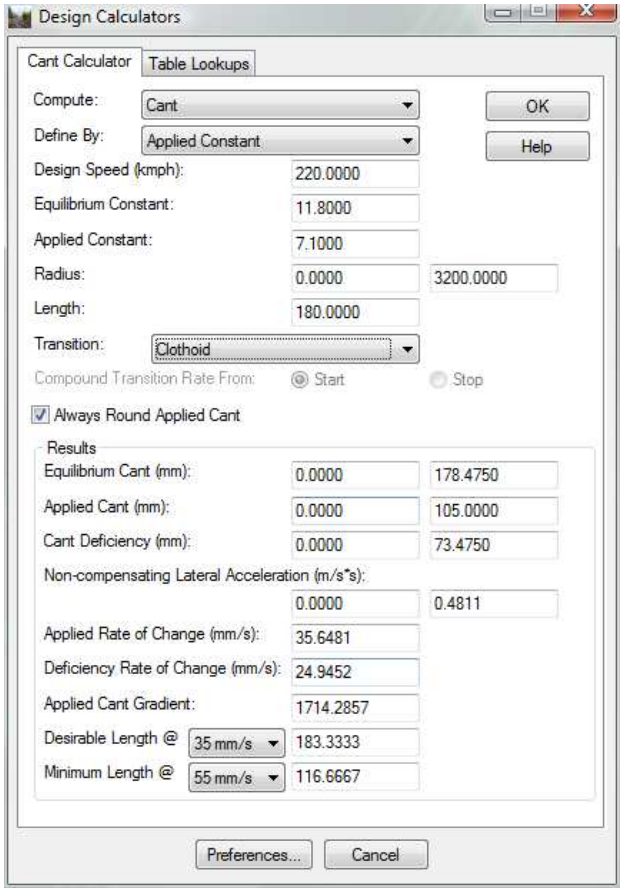
- Horizontal alignment design based upon cant (i.e. superelevation)
  - Arc or chord definition alignments
  - Horizontal spiral transition types
    - Clothoids + cubic parabola, AREMA, bi-quadratic parabola, Bloss, sinusoid, cosine and Viennese
    - 1 to 1 relationship between the horizontal transition and the cant transition
- Vertical alignment design
  - Parabolic vertical curves
  - Circular vertical curves + clothoids
- Turnouts are a type of geometry
  - Multiple types (single, double and slips)
  - Multiple bending methodology

Alignment Design

- Multiple methods to define horizontal and vertical geometry
  - Curve sets
  - Fix / Float / Free Elements
  - Single / multi-element regression analysis
    - The process of best fitting true geometry to raw survey points
    - Quick regression
  - A *horizontal* set of commands and a corresponding *vertical* set of commands
    - Reduces training issues
  - Tools are interchangeable
    - Use curve sets, elements or regression in combination

Cant

- Standard international railway terminology
  - Equilibrium cant, applied cant, cant deficiency, etc.
- Units
  - Millimeters, millimeters / second
  - Inches, inches / second
- Calculations
  - Standard equilibrium equations that be found in well known literature
- Cant Integrated into Horizontal Design
- **This is <u>not</u> a road solution applied to rail*!***



Bentley

Turnouts

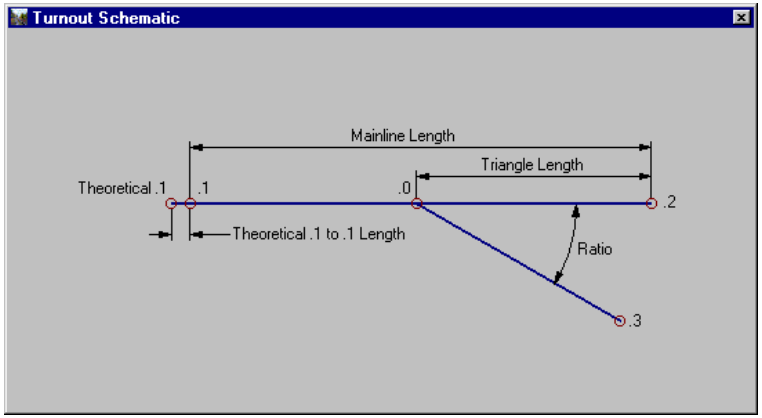
- Single, double and slips
  - Tangential and non-tangential turnouts
- Multiple bending / flexing methods to satisfy multiple international standards

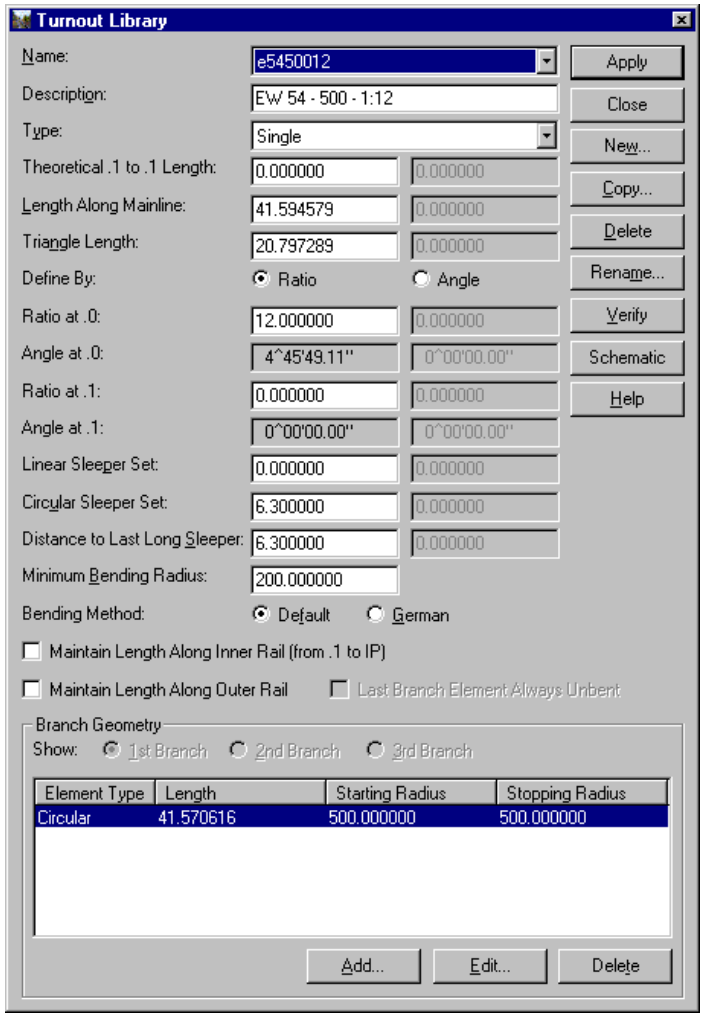
Turnout Library

- Contains a standard (base) definition and many international standards eg:
  - German (heavy & light rail)
  - Swiss
  - Austrian
  - Australian
  - UK (113A's & RT60's)
  - Indian
  - Dutch
  - Spanish (heavy & light rail)
  - AREMA (US + Canada)
  - South Africa
  - UIC
  - …and many more
- The user can easily create/add turnouts to library

Turnout Library

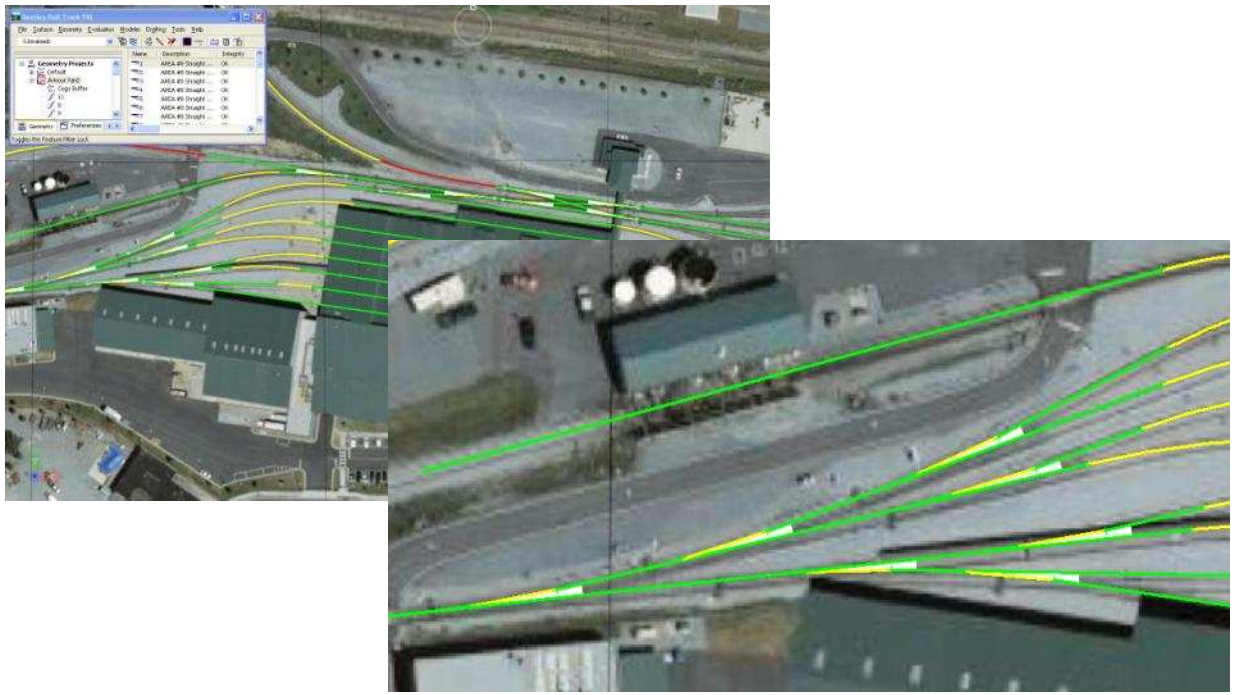
- User definable libraries
  - Single branch
  - Double branch
  - Single slip
  - Double slip
  - Diamond crossing

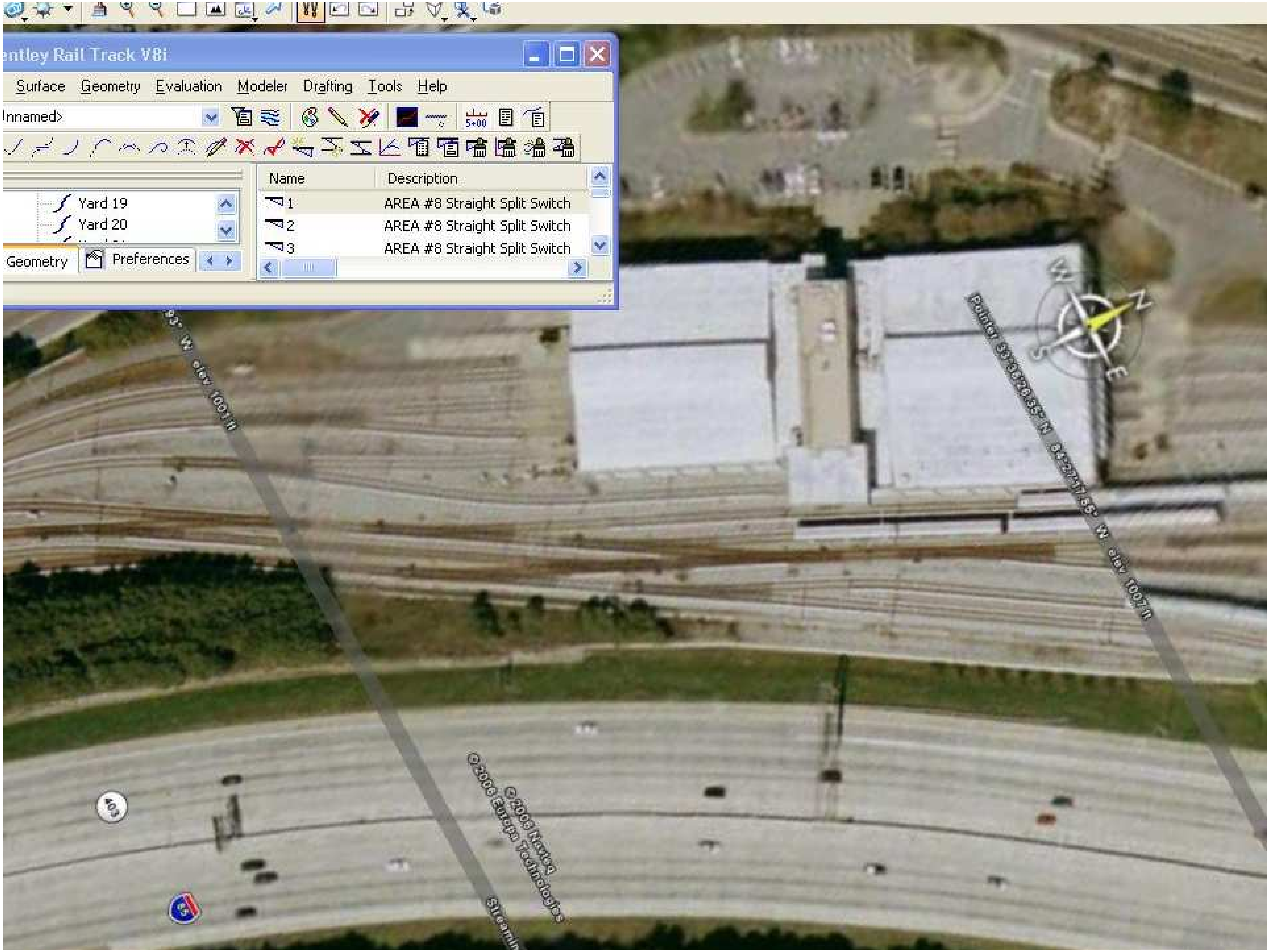




Example: Re-connecting turnouts

- Horizontal alignments and associated turnouts are automatically reconnected after changes.
- Design rules maintained




entley Rail Track V8i
Surface Geometry Evaluation Modeler Drafting Tools Help
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Geometry
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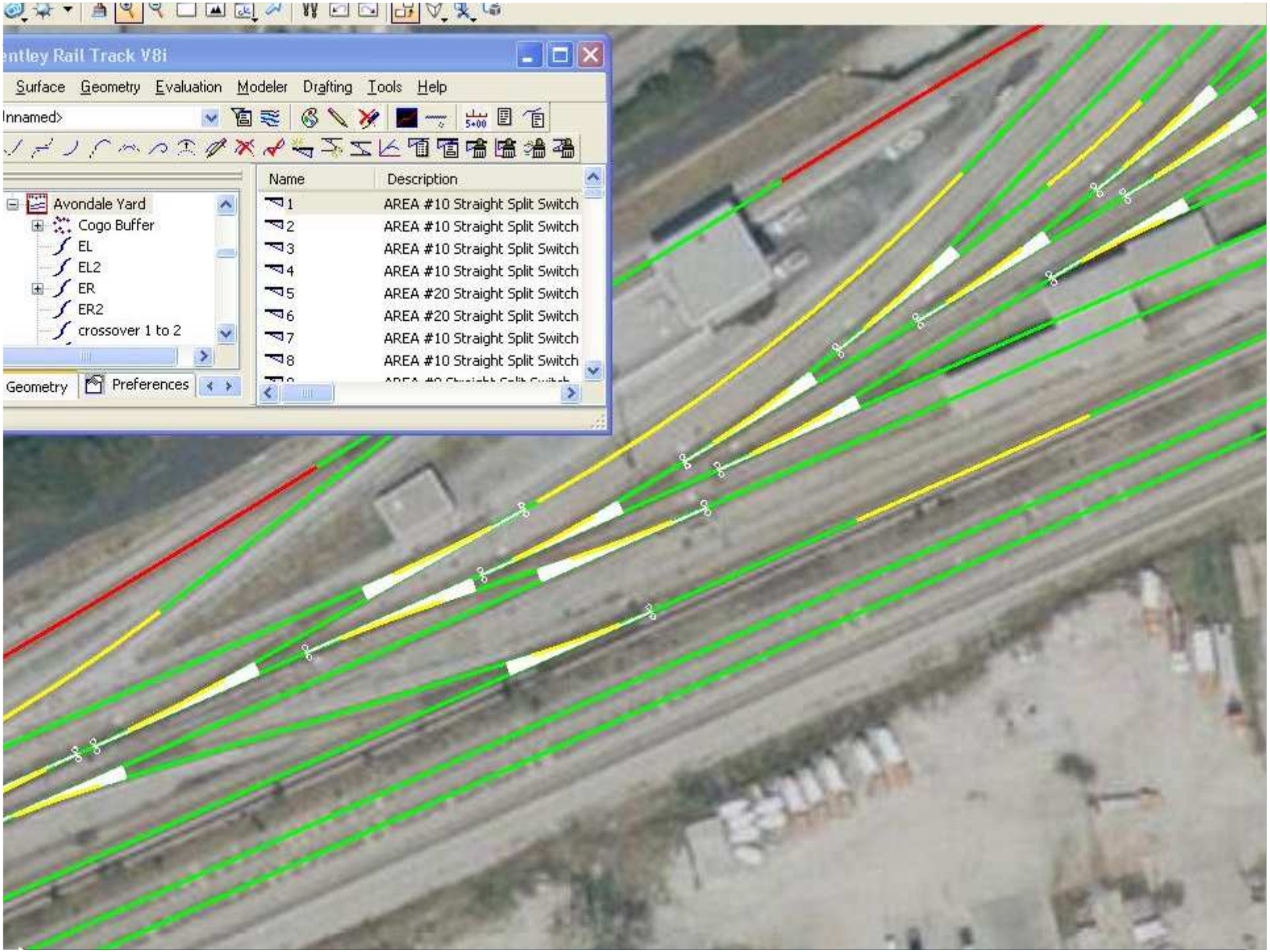
Description
1 AREA #8 Straight Split Switch
2 AREA #8 Straight Split Switch
3 AREA #8 Straight Split Switch
93° W elev 1001 ft
Pointer 33°38'20.35" N 84°27'17.85" W elev 1007 ft
© 2008 Navteq
© 2008 Europa Technologies
403
85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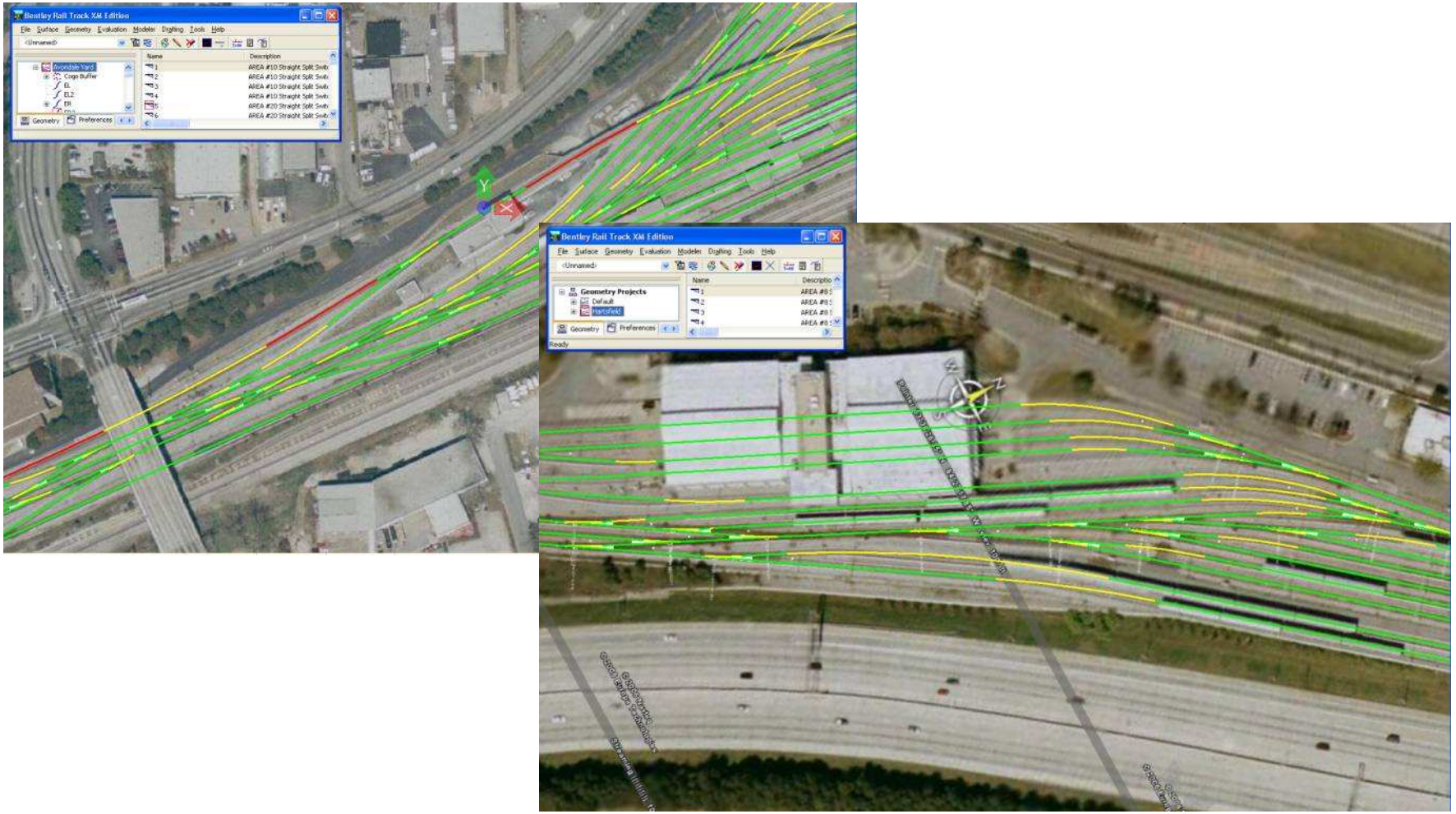
Description
1 AREA #10 Straight Split Switch
2 AREA #10 Straight Split Switch
3 AREA #10 Straight Split Switch
4 AREA #10 Straight Split Switch
5 AREA #20 Straight Split Switch
6 AREA #20 Straight Split Switch
7 AREA #10 Straight Split Switch
8 AREA #10 Straight Split Switch

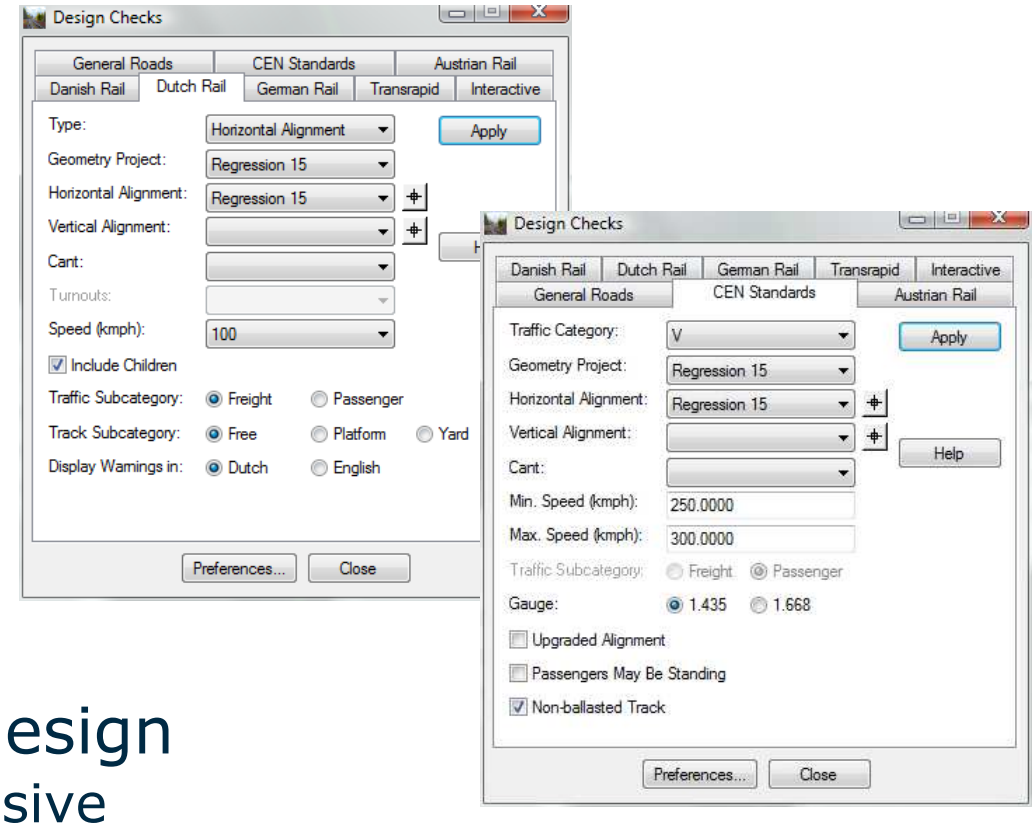
Resulting in models like these yards!



Bentley

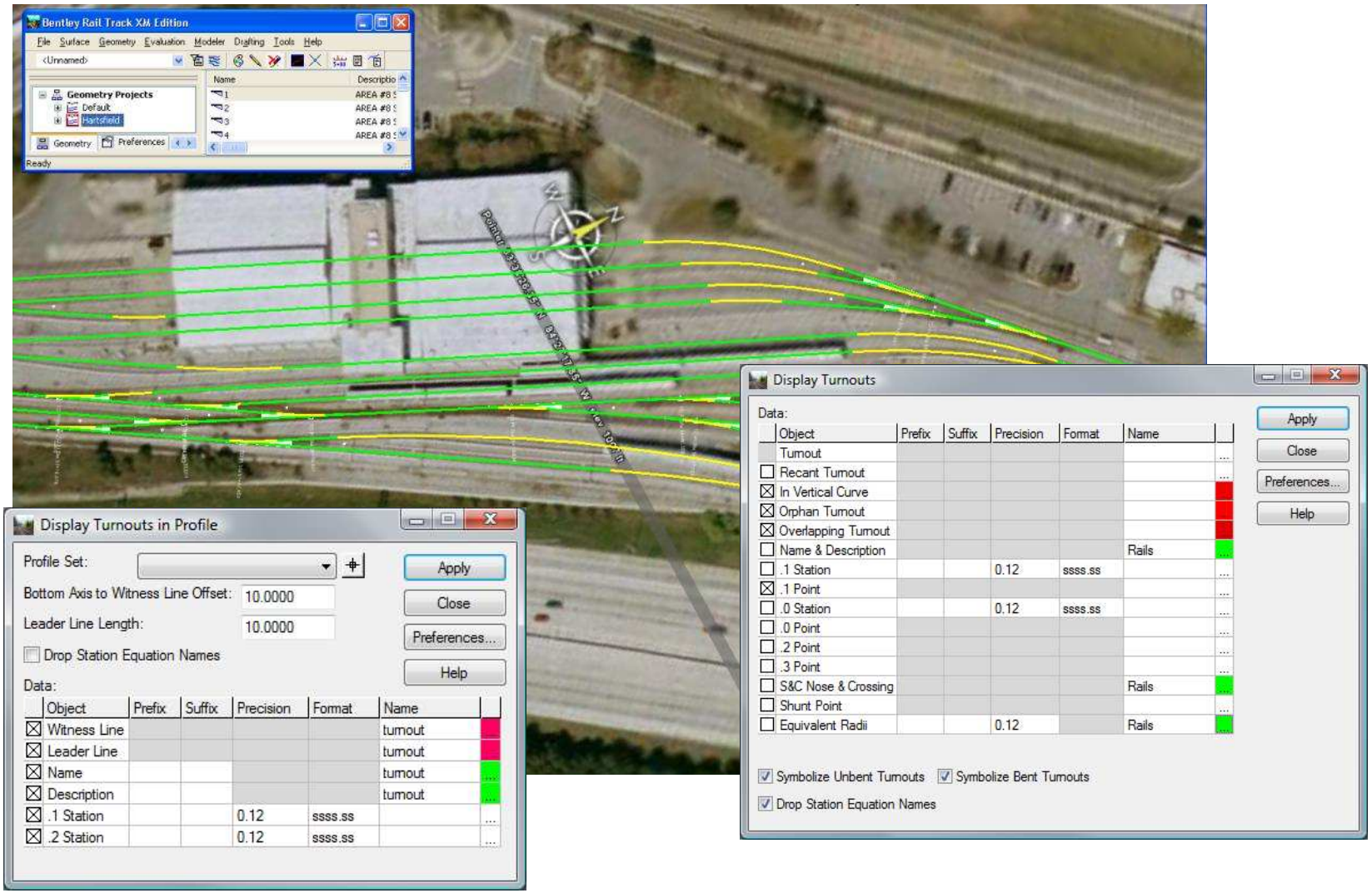
Detailed Design Checking

- Includes
  - CEN Standards
  - Austrian Rail
  - Danish Rail
  - Dutch Rail
  - German Rail
  - Transrapid
  - Italian
  - Indian
  - French



- Execute as you design
  - Interactive + passive
- Execute as a post-design process
  - Ideal for checking a consultant's design
- Written to match the railway's requirements

Graphical design checking

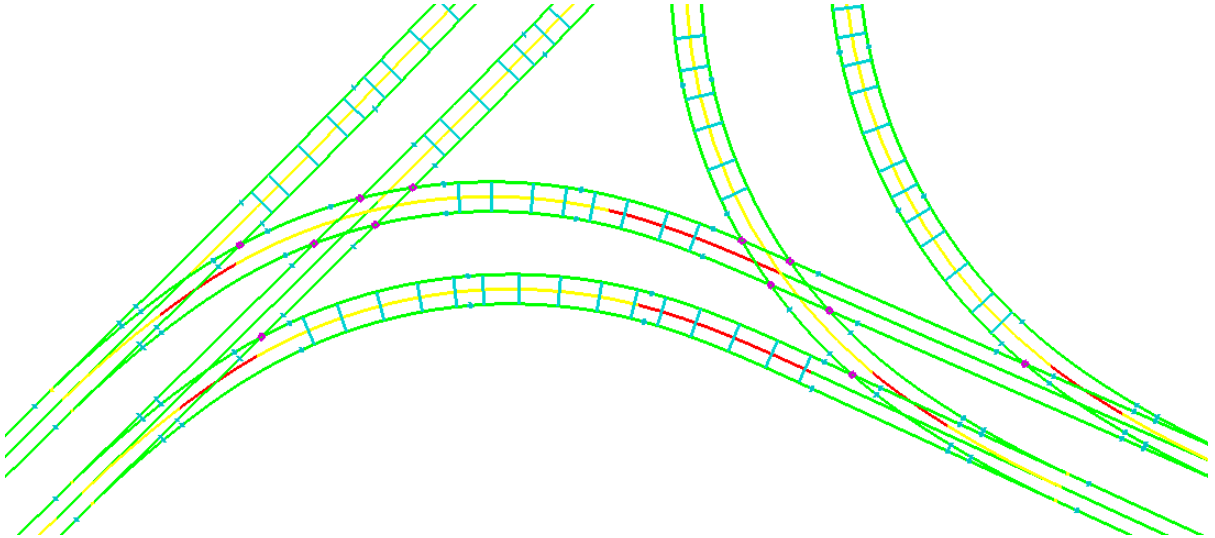


Light Rail Design & Manufacturing

- Specialised functionality for light rail systems
- Switches and crossings are generally unique geometry
- Jointed rail
- Pre-bent rails
- Pre-drilled rails
- Distance keepers

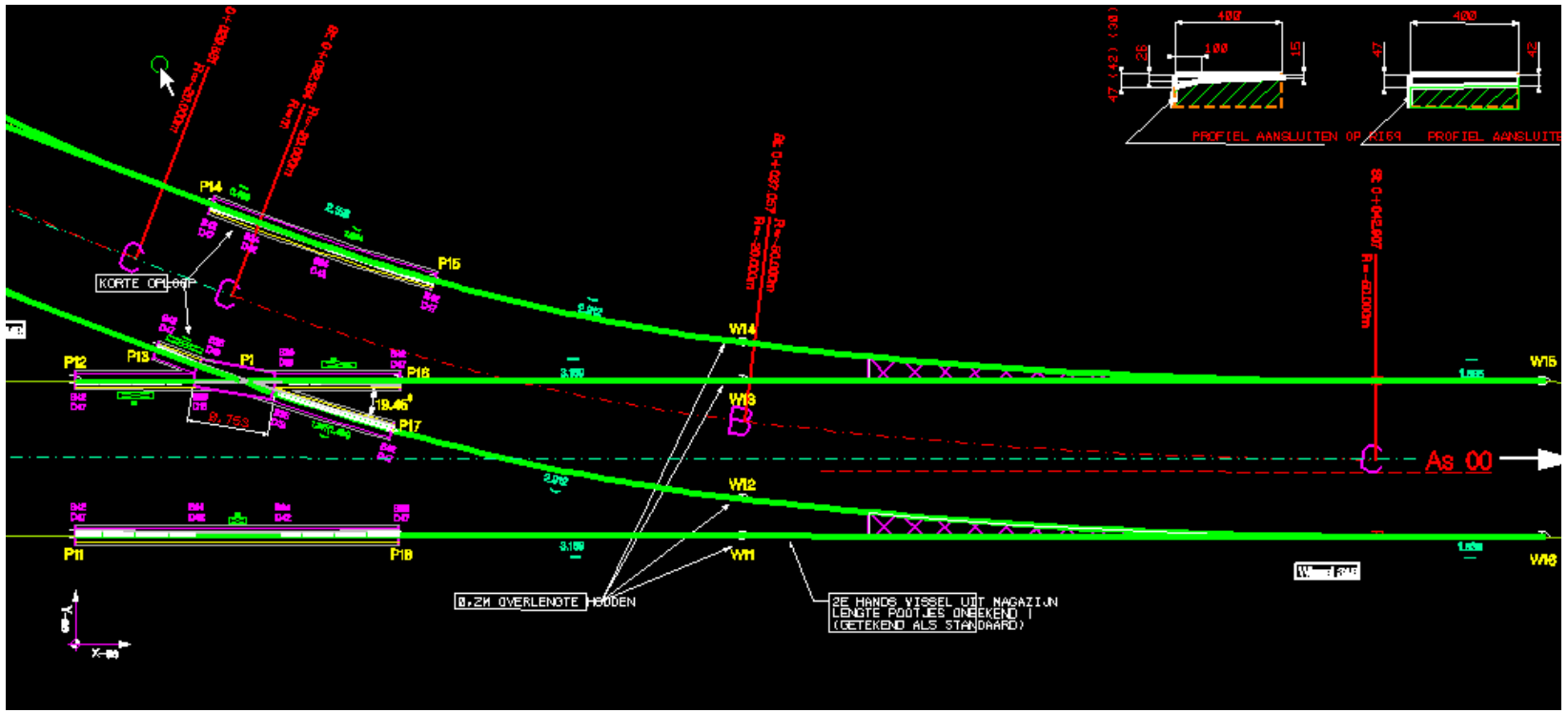
Light Rail Model

- Creation and editing of a 3D model, based upon horizontal, vertical and cant
  - Rails
  - Joints, crossings & key-points
  - Distance keepers



Light Rail Manufacturing

- Tools for fabrication and construction detailing



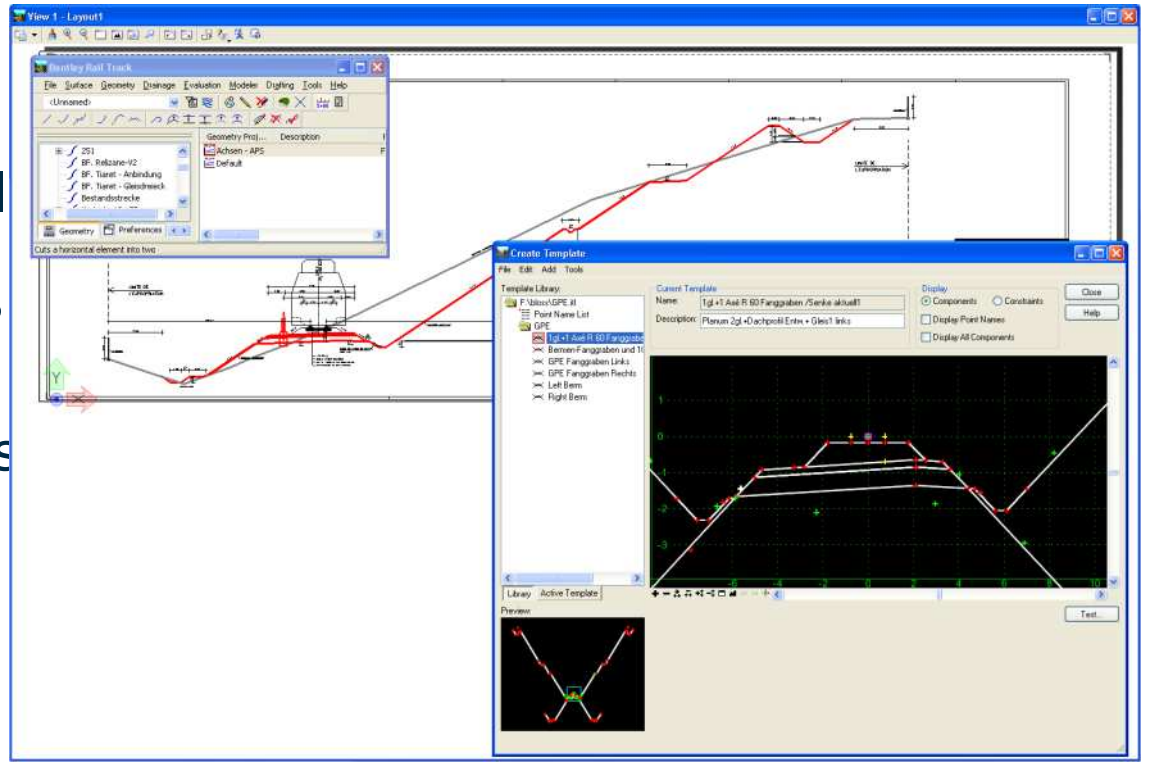
The resulting model is then exported for manufacturing

Maglev

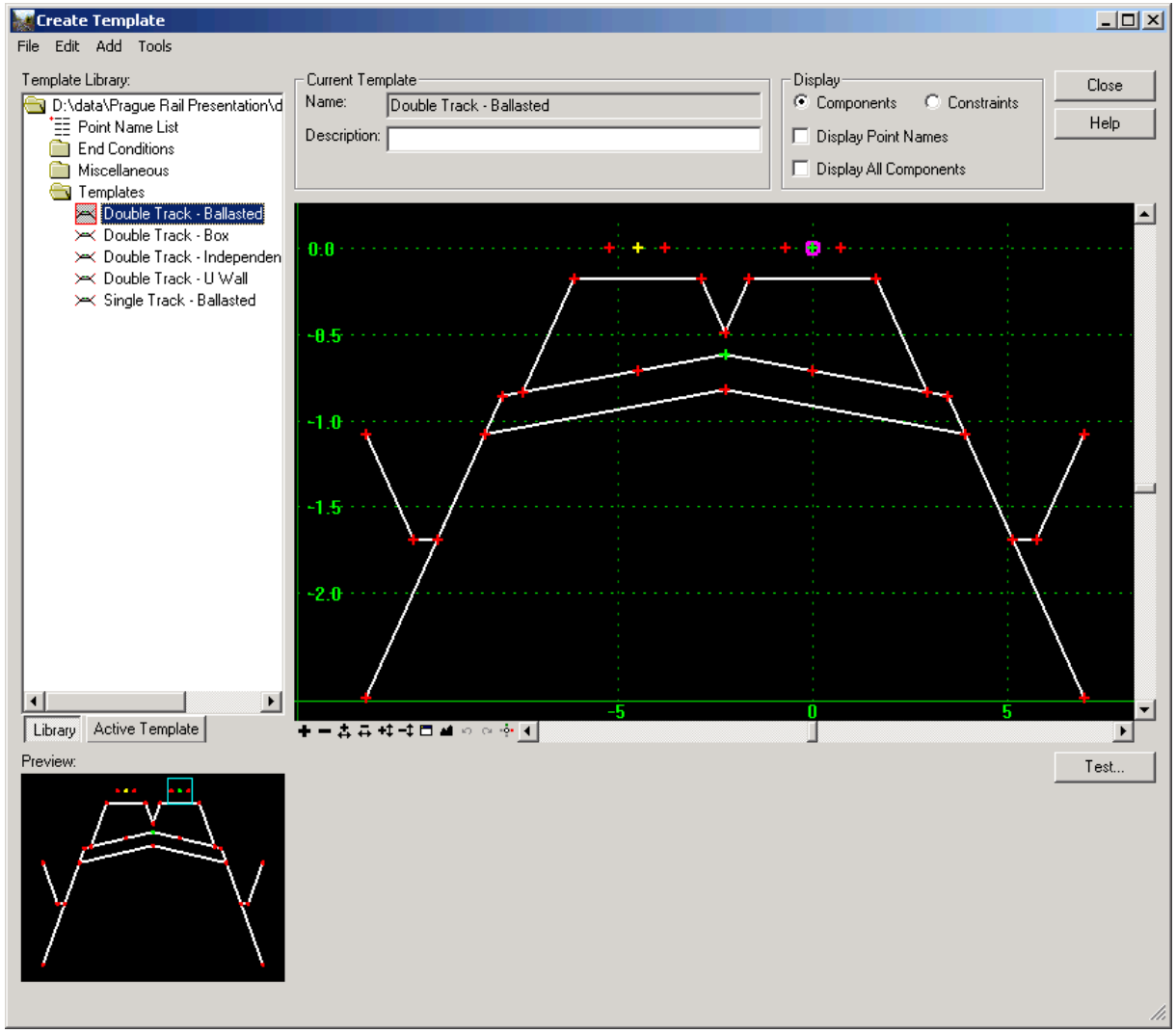
- Specific functionality to support Transrapid in the late 90’s
- Transrapid technology is now operational in China

Earthwork Modeling & Templates

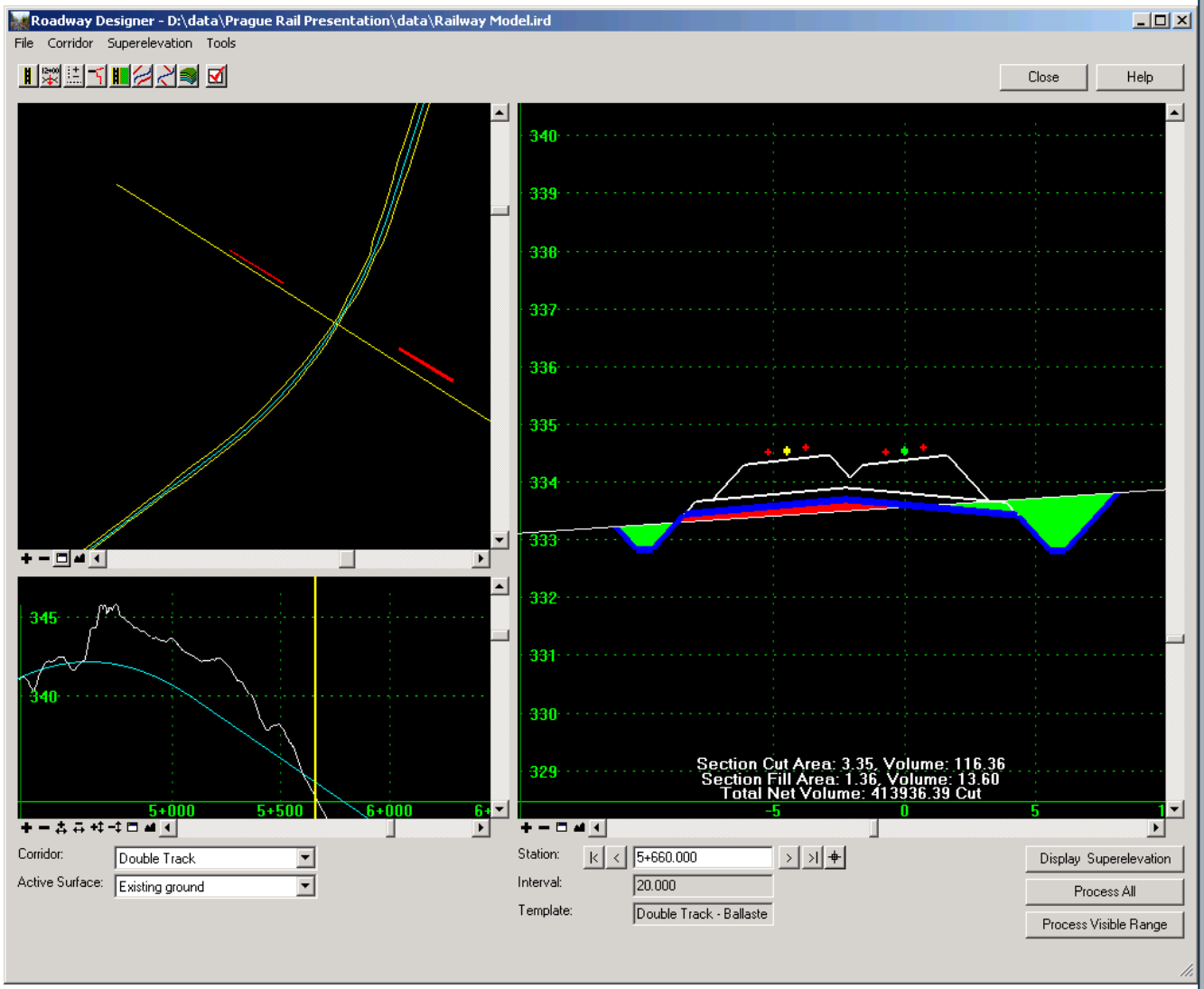
- Components
  - Closed shapes that represent materials
  - Rails & sleepers
  - Ballast
  - Subballast
  - Other material
- End conditions
  - Ditches
  - Cut / fill slopes



Create Template with Ballasted Section

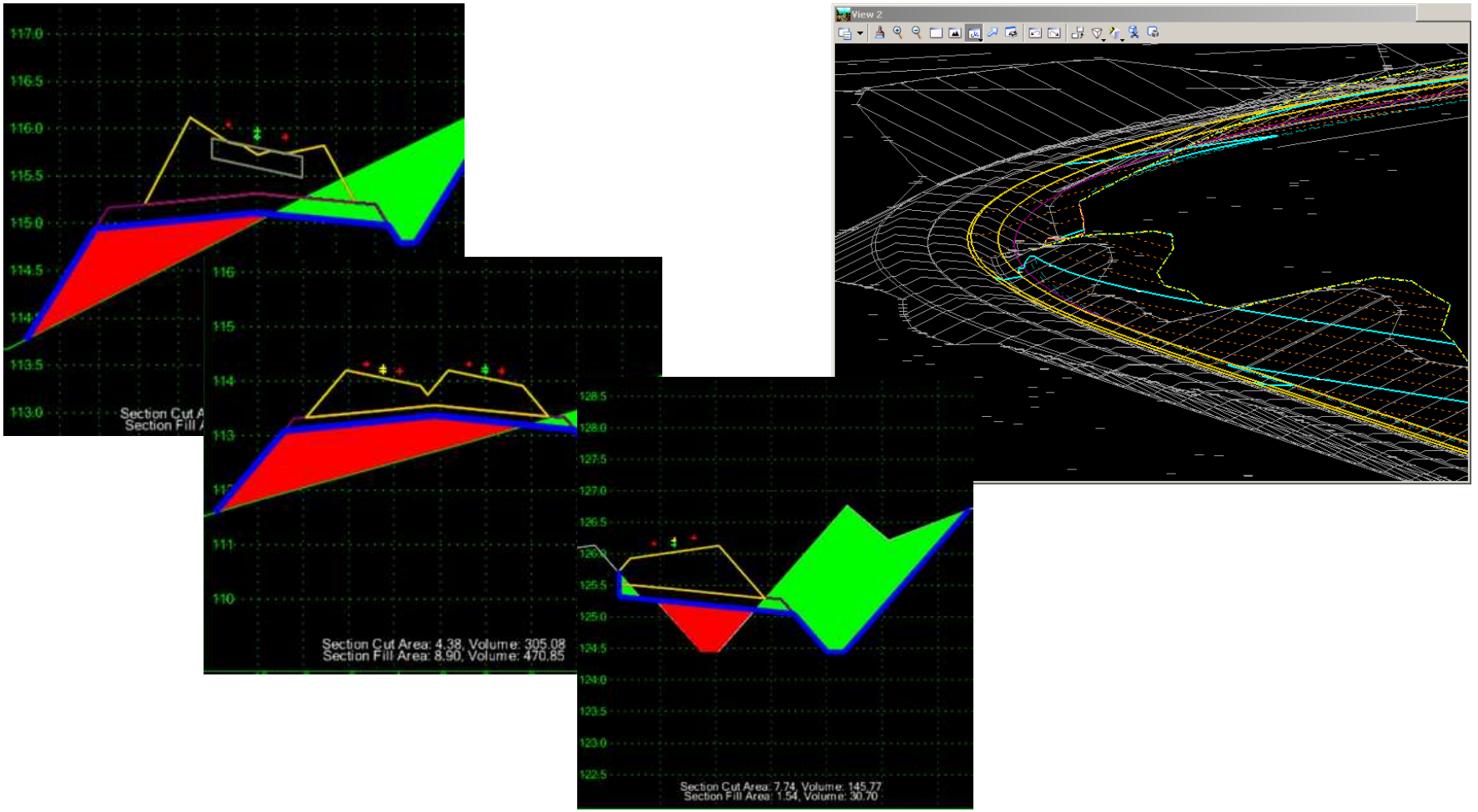


Roadway Design with Railway Template

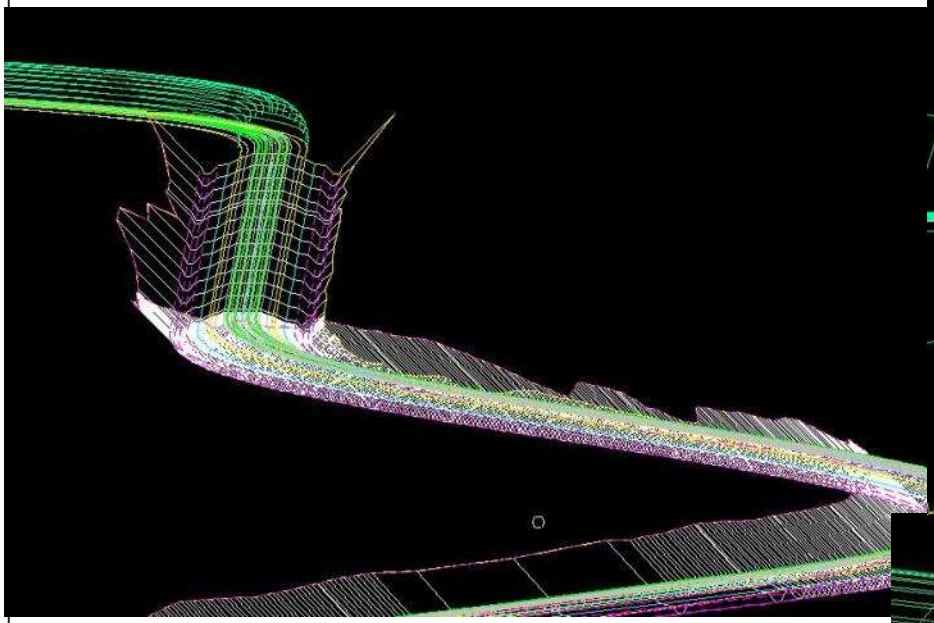


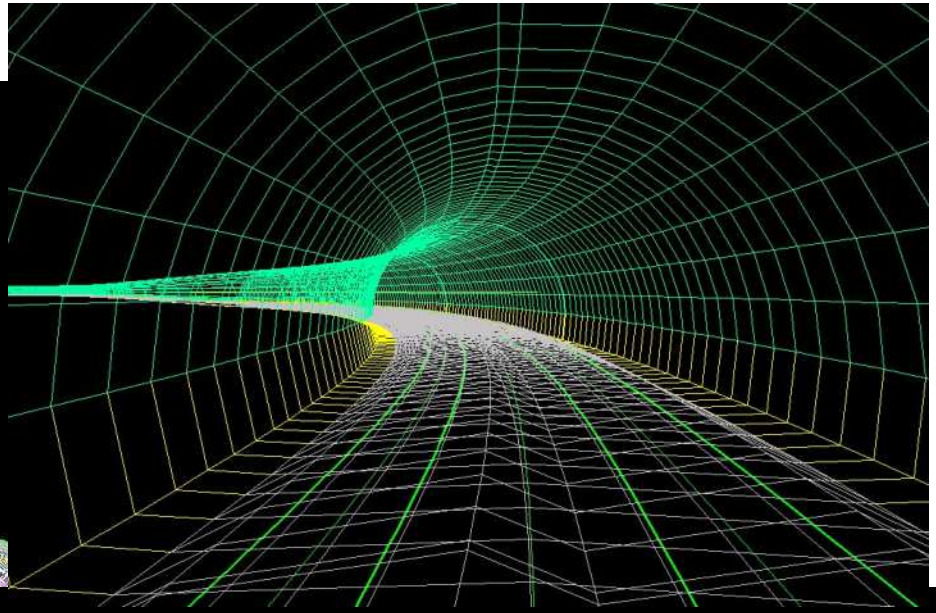
Bentley

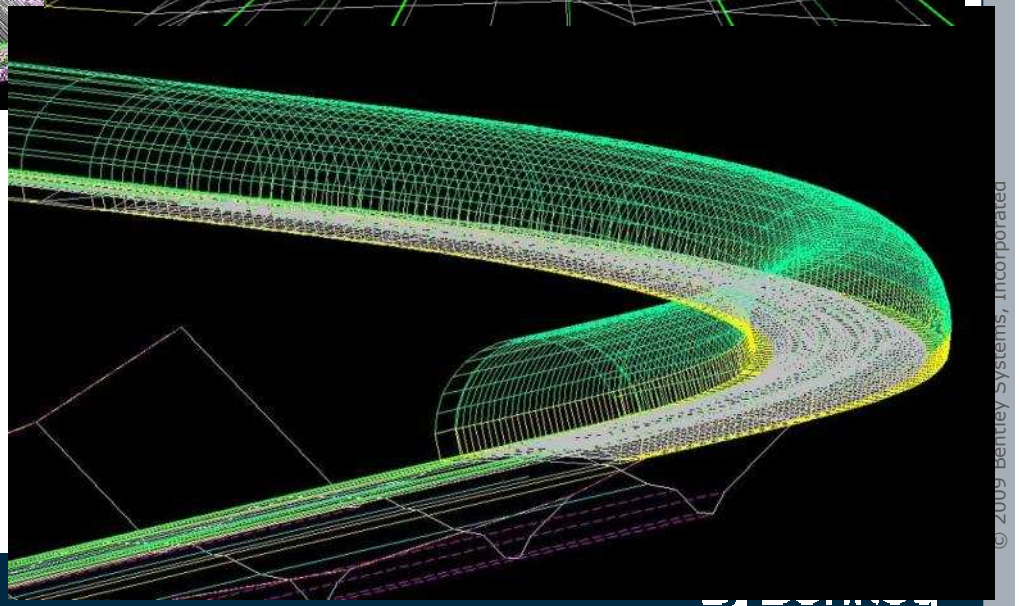
Easily create track models…



Easily create tunnel models….

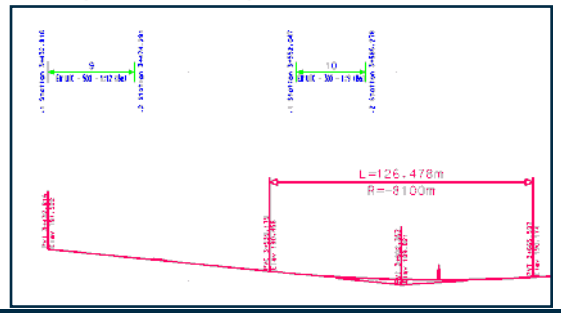






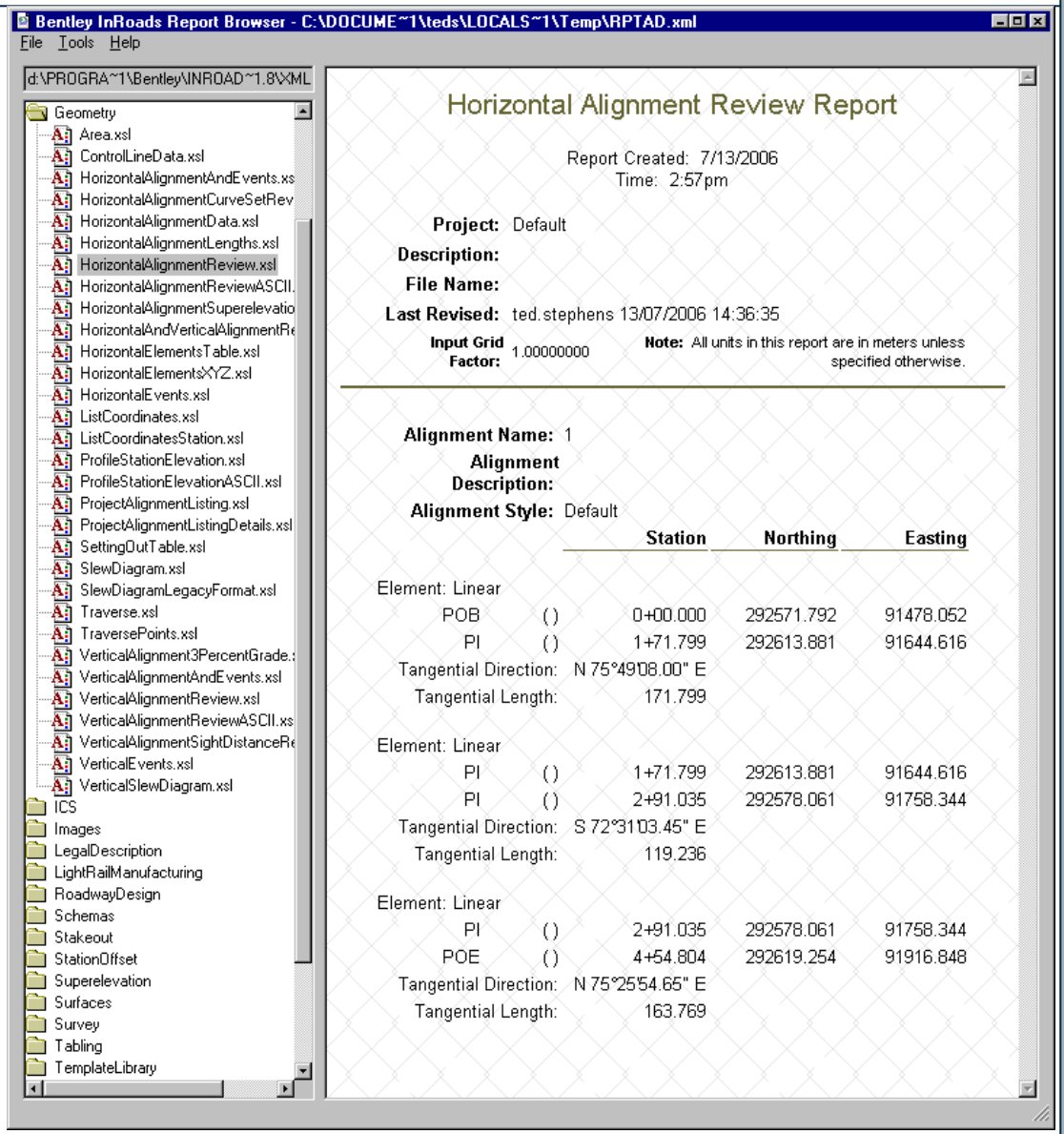
Automated Drawing Production

- User configurable for national and project standards
  - Plan
  - Profile
  - Cross section
  - Wireline perspective
  - Rendered images
- Drawings automatically produced from model data
- Specialist drawings (eg: switch profiles and slews))



Reports

- User configurable using XML style sheets



Data Export

- LandXML
  - Geometry and surface models
- Instrumentation
  - Trimble
  - Leica
- Tamping Machines
  - Plasser & Theurer – WinALC format
  - Matisa – PALAS format

Rendered images and VR

Direct creation of images and VR models using MicroStation.

Image taken from Bentley V8i Virtual Reality model of Luton Station

Bentley Rail Track

For more information, please visit:

www.bentley.com

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Sustaining Infrastructure