

Bentley Rail Track

An introduction

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

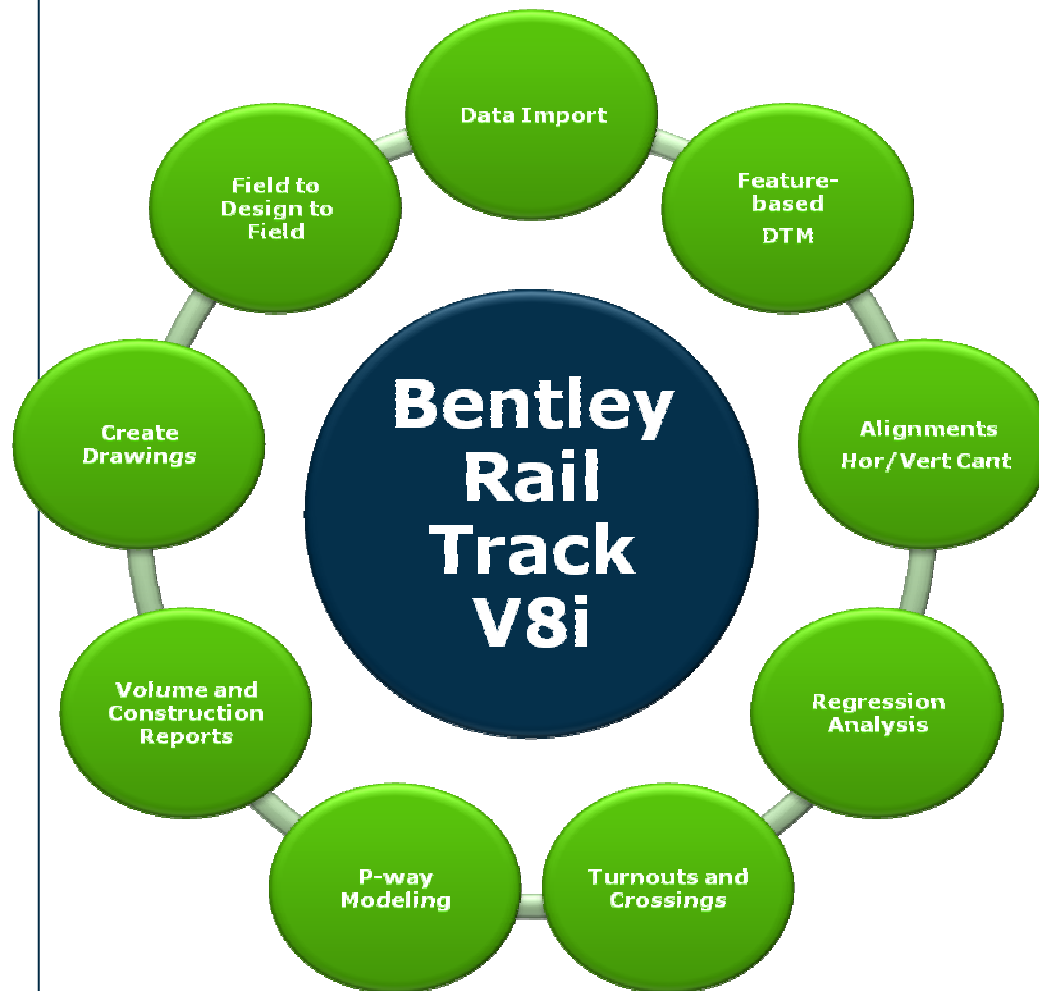
System Functionality

- 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

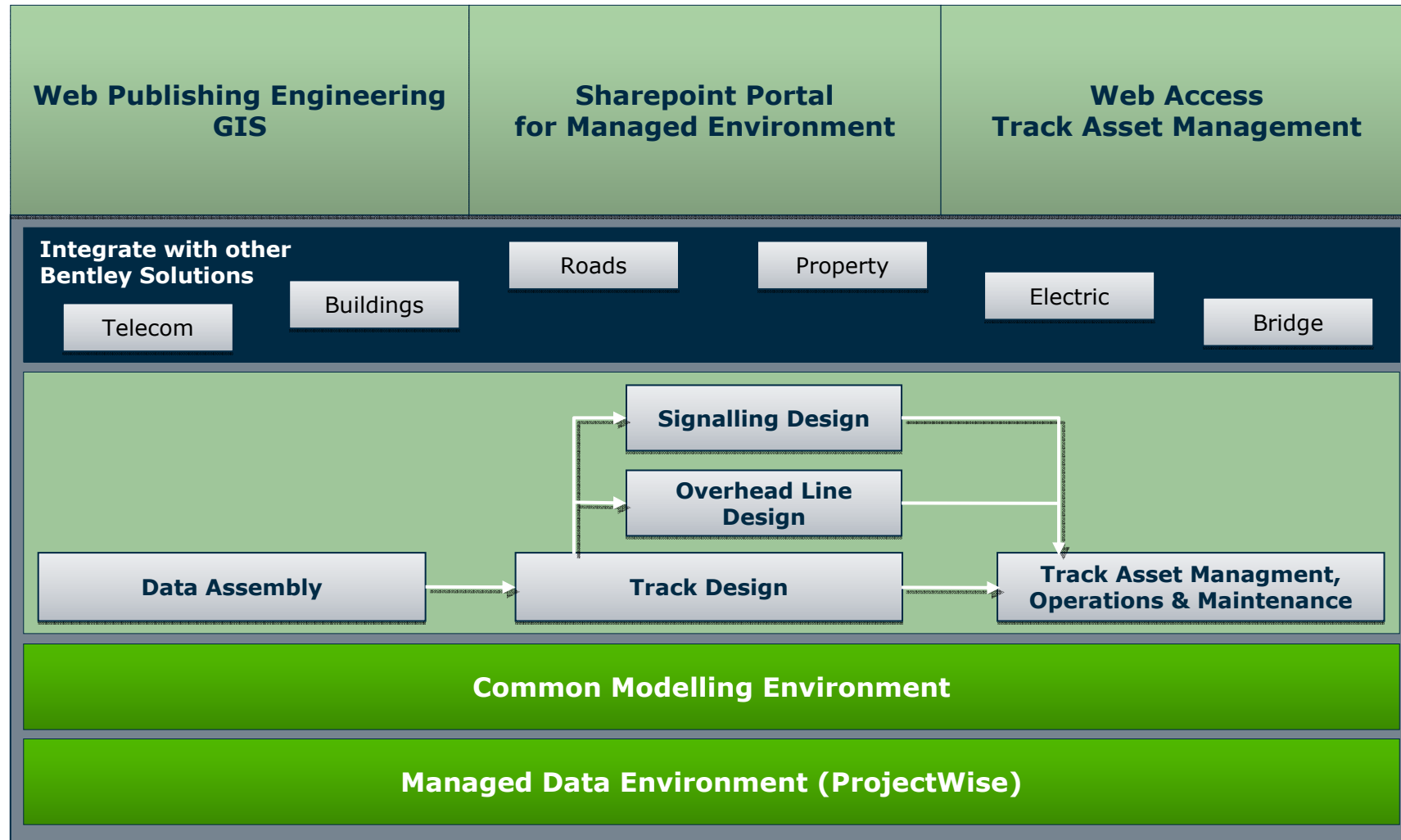
- User defined outputs
 - Drawings
 - Reports and schedules
 - Manufacturing details
- Data export
 - Machines - Plasser & Theurer and Matisa
 - Field computers
 - Manufacturing
- Industry standard data (eg: DGN, DWG, XML)

Bentley Rail Track



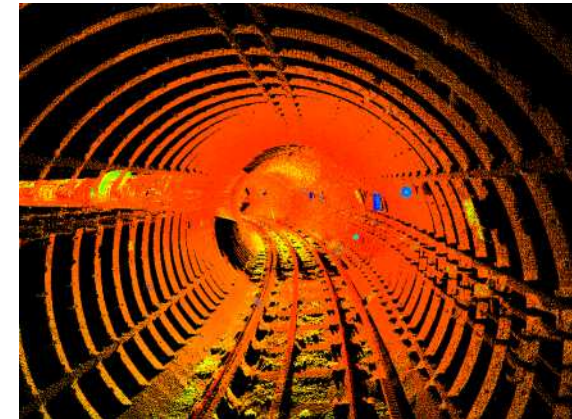
- ✓ A global rail design software
- ✓ Automates design workflows for every kind of rail projects
- ✓ Supports new and upgrade projects for single or multiple tracks
- ✓ Standardizes project outputs – drawings, volumes, construction reports etc..
- ✓ Enables design checking and validation
- ✓ Design to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



Data Import Tools

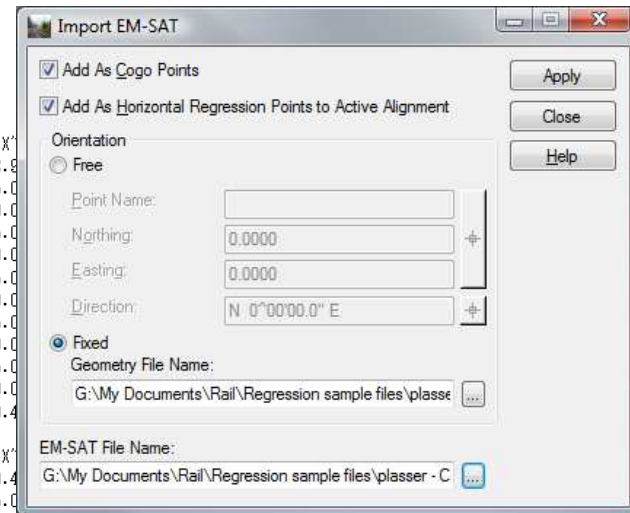
- LandXML
 - Geometry and surface models
- Vendor Specific
 - Trimble Upload Add In
 - Geometry and surface models
 - Lieca Upload Add In
 - Geometry and surface models
 - Geometric Measurement systems
 - Plasser & Theurer (EM-SAT)

Field to Design

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

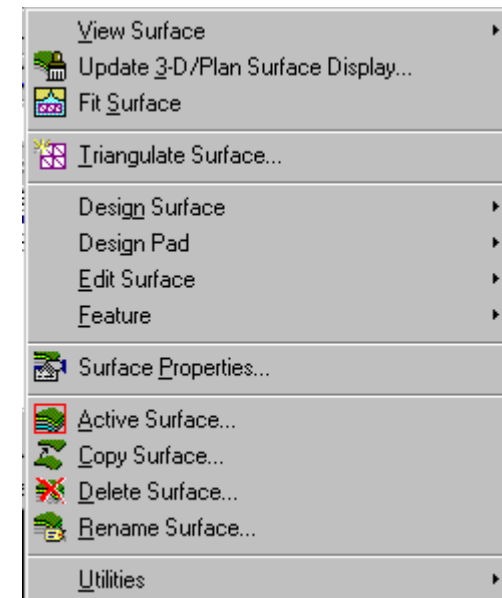


Stich	Lage	Stich H	e	7	Spurweite														
0.05.07		00:30:20																	
	232149.490		"lag1d12.geo"	"lag1d12.FIX"															
	0.0000	0.0000	0.0036	1.4316	232188.9														
	0.0054	-0.0151	-0.0020	1.4332	232195.0														
	0.0078	-0.0175	-0.0059	1.4355	232190.0														
	0.0082	-0.0136	-0.0109	1.4350	232185.0														
	0.0082	-0.0088	-0.0098	1.4344	232180.0														
	0.0057	-0.0112	-0.0075	1.4357	232175.0														
	0.0064	-0.0088	-0.0046	1.4355	232170.0														
	0.0052	-0.0095	-0.0047	1.4356	232185.0														
	0.0026	0.0017	-0.0066	1.4312	232160.0														
	0.0039	-0.0080	0.0002	1.4334	232155.0														
	0.0004	-0.0008	0.0020	1.4355	232150.0														
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	-0.0002	0.0140	-0.0017	1.4330	232135.000	0.0000	0.0000	0.0000											
	0.0071	0.0227	-0.0034	1.4342	232130.000	0.0000	0.0000	0.0000											
	0.0047	0.0399	0.0017	1.4358	232125.000	0.0000	0.0000	0.0000											
	0.0074	0.0519	0.0009	1.4300	232120.000	0.0000	0.0000	0.0000											
D	232115.000	0.0065	0.0450	-0.0043	1.4330	232115.000	0.0000	0.0000	0.0000										
D	232110.000	0.0046	0.0113	-0.0028	1.4340	232110.000	0.0000	0.0000	0.0000										
D	232105.000	0.0040	0.0039	0.0033	1.4330	232105.000	0.0000	0.0000	0.0000										
D	232100.000	0.0004	-0.0009	0.0079	1.4325	232100.000	0.0000	0.0000	0.0000										
D	232099.320	0.0000	0.0000	0.0076	1.4339	232099.320	0.0000	0.0000	0.0000										



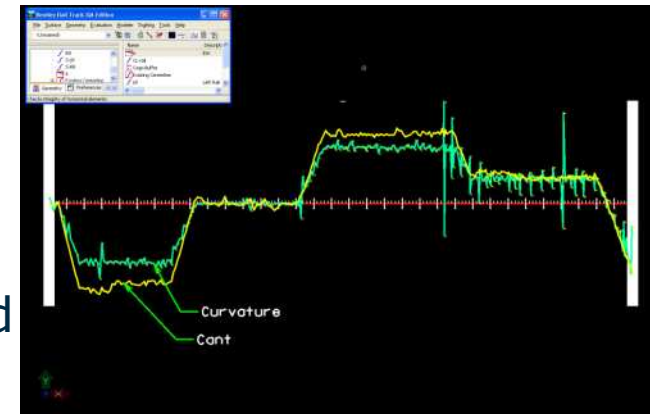
Surface Analysis

- 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...

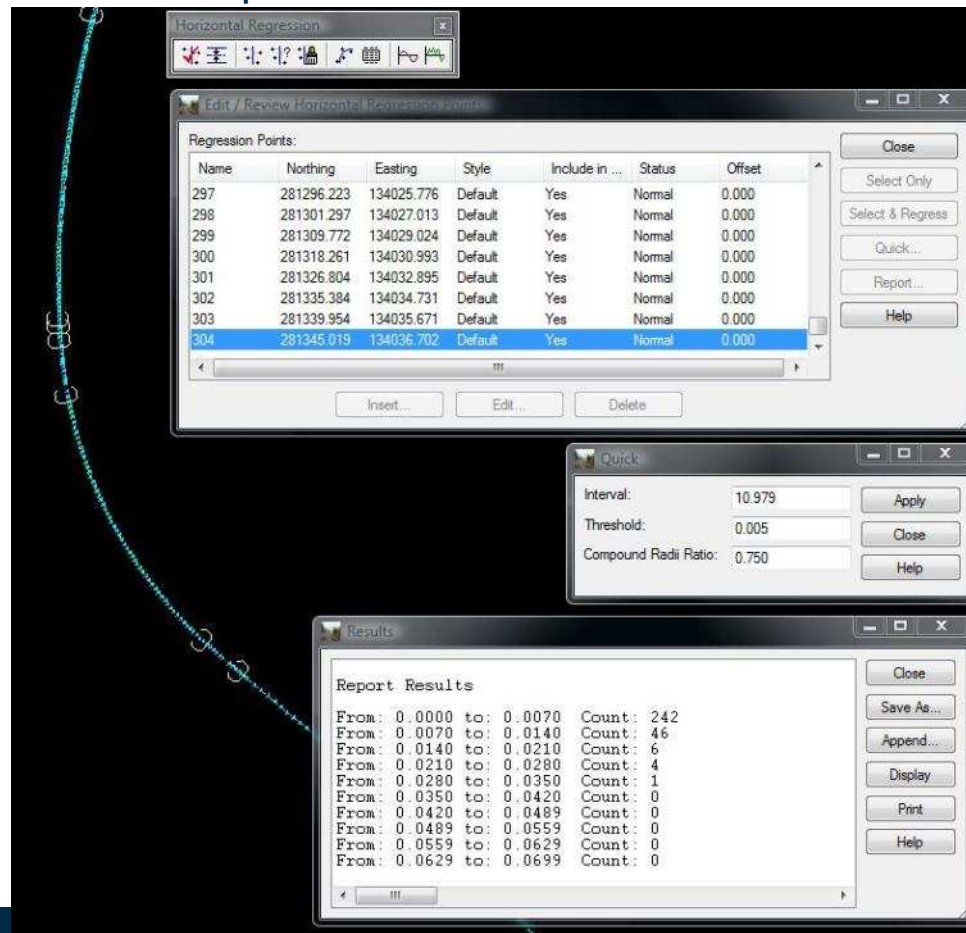
- Pre-regression data validation
- Point selection and sorting
 - Survey data ordering is not required
- Curvature diagrams
 - Indicates approximate locations of specific elements and their types
 - Indicates questionable data
 - Inclusion of cant, if surveyed, enhances the field data
- Edit / review
 - 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

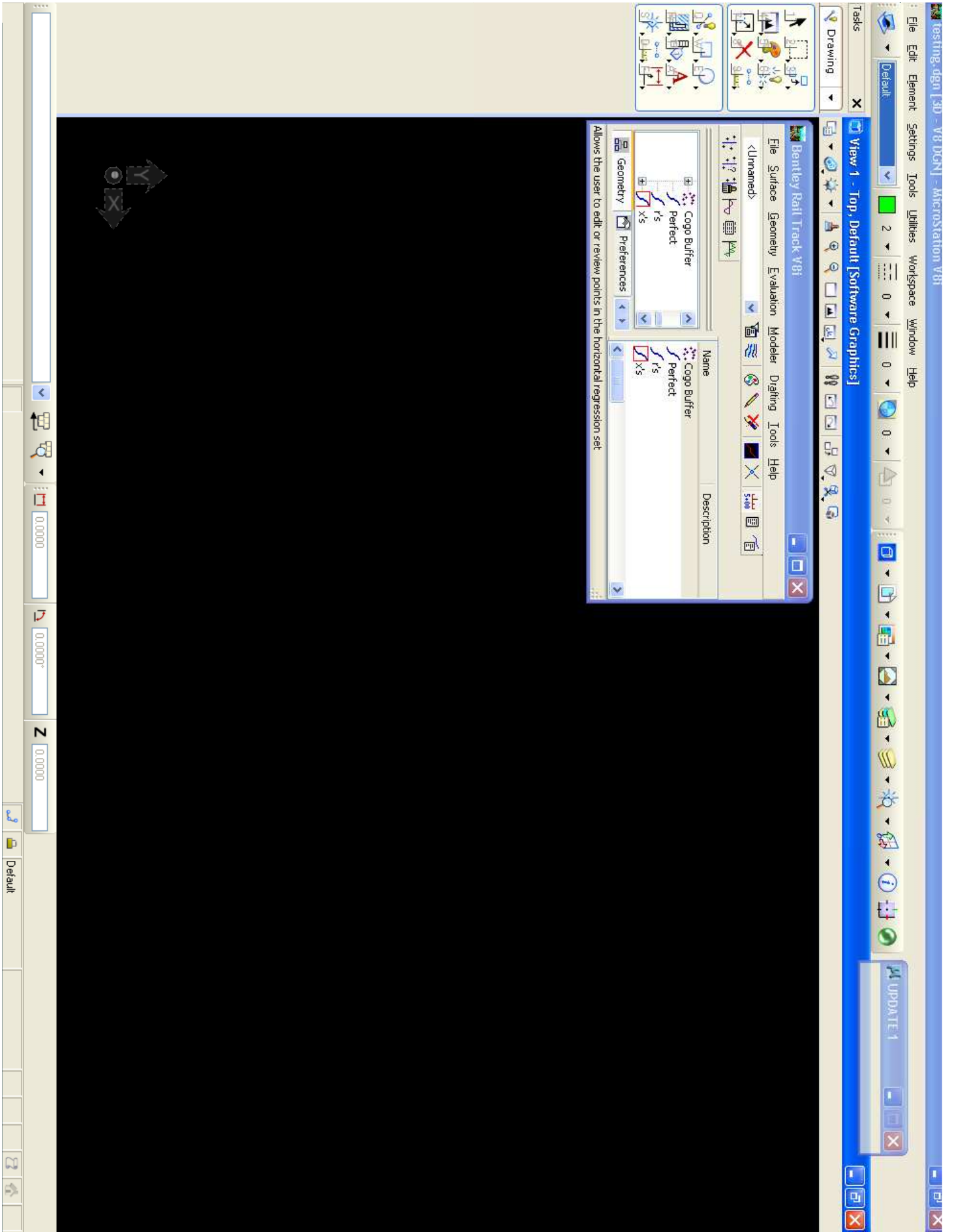


Quick Regression

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 not a road solution applied to rail!**

The screenshot shows the 'Design Calculators' dialog box with the 'Cant Calculator' tab selected. The 'Compute' dropdown is set to 'Cant' and 'Define By' is set to 'Applied Constant'. The 'Design Speed (kmph)' is 220.0000. The 'Equilibrium Constant' is 11.8000 and the 'Applied Constant' is 7.1000. The 'Radius' is 0.0000 and the 'Length' is 180.0000. The 'Transition' is set to 'Clothoid'. The 'Compound Transition Rate From' has 'Start' selected. The 'Always Round Applied Cant' checkbox is checked. The 'Results' section shows: Equilibrium Cant (mm) 0.0000 / 178.4750, Applied Cant (mm) 0.0000 / 105.0000, Cant Deficiency (mm) 0.0000 / 73.4750, Non-compensating Lateral Acceleration (m/s²) 0.0000 / 0.4811, Applied Rate of Change (mm/s) 35.6481, Deficiency Rate of Change (mm/s) 24.9452, Applied Cant Gradient 1714.2857, Desirable Length @ 35 mm/s 183.3333, and Minimum Length @ 55 mm/s 116.6667. Buttons for 'OK', 'Help', 'Preferences...', and 'Cancel' are visible.

Field	Value 1	Value 2
Design Speed (kmph)	220.0000	
Equilibrium Constant	11.8000	
Applied Constant	7.1000	
Radius	0.0000	3200.0000
Length	180.0000	
Transition	Clothoid	
Compound Transition Rate From	Start	Stop
Always Round Applied Cant	<input checked="" type="checkbox"/>	
Equilibrium Cant (mm)	0.0000	178.4750
Applied Cant (mm)	0.0000	105.0000
Cant Deficiency (mm)	0.0000	73.4750
Non-compensating Lateral Acceleration (m/s²)	0.0000	0.4811
Applied Rate of Change (mm/s)	35.6481	
Deficiency Rate of Change (mm/s)	24.9452	
Applied Cant Gradient	1714.2857	
Desirable Length @ 35 mm/s	183.3333	
Minimum Length @ 55 mm/s	116.6667	

Turnouts

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

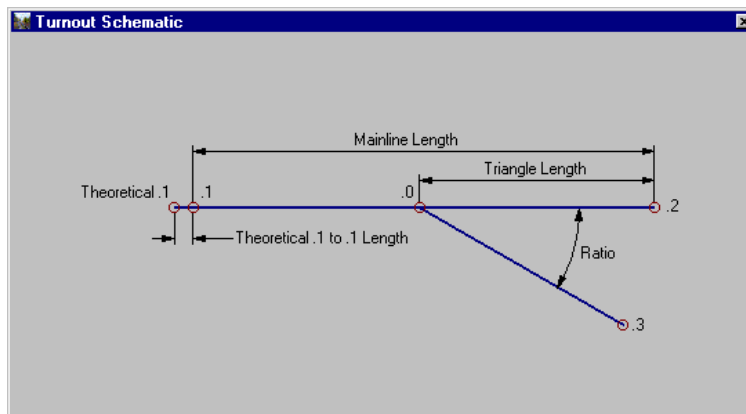


Turnout Library

- 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



Turnout Library

Name: e5450012
Description: EW 54 - 500 - 1:12
Type: Single

Theoretical .1 to .1 Length: 0.000000
Length Along Mainline: 41.594579
Triangle Length: 20.797289

Define By: Ratio Angle

Ratio at .0: 12.000000
Angle at .0: 4°45'49.11"
Ratio at .1: 0.000000
Angle at .1: 0°00'00.00"

Linear Sleeper Set: 0.000000
Circular Sleeper Set: 6.300000
Distance to Last Long Sleeper: 6.300000
Minimum Bending Radius: 200.000000

Bending Method: Default German

Maintain Length Along Inner Rail (from .1 to IP)
 Maintain Length Along Outer Rail Last Branch Element Always Unbent

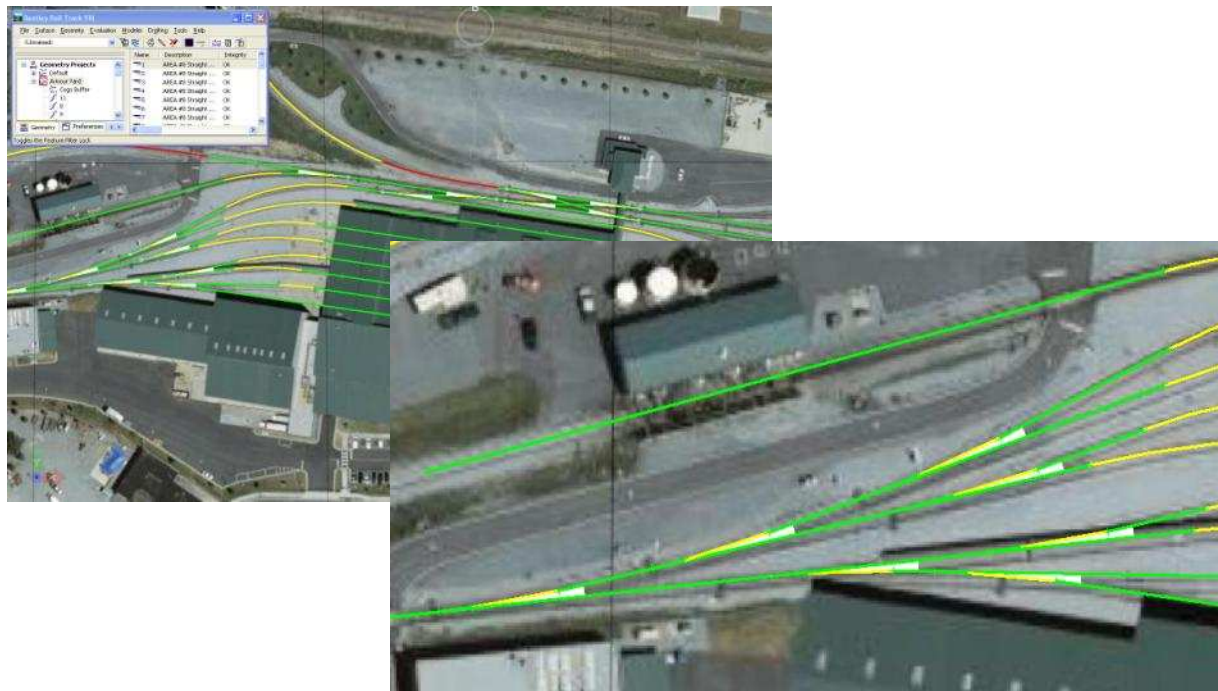
Branch Geometry
Show: 1st Branch 2nd Branch 3rd Branch

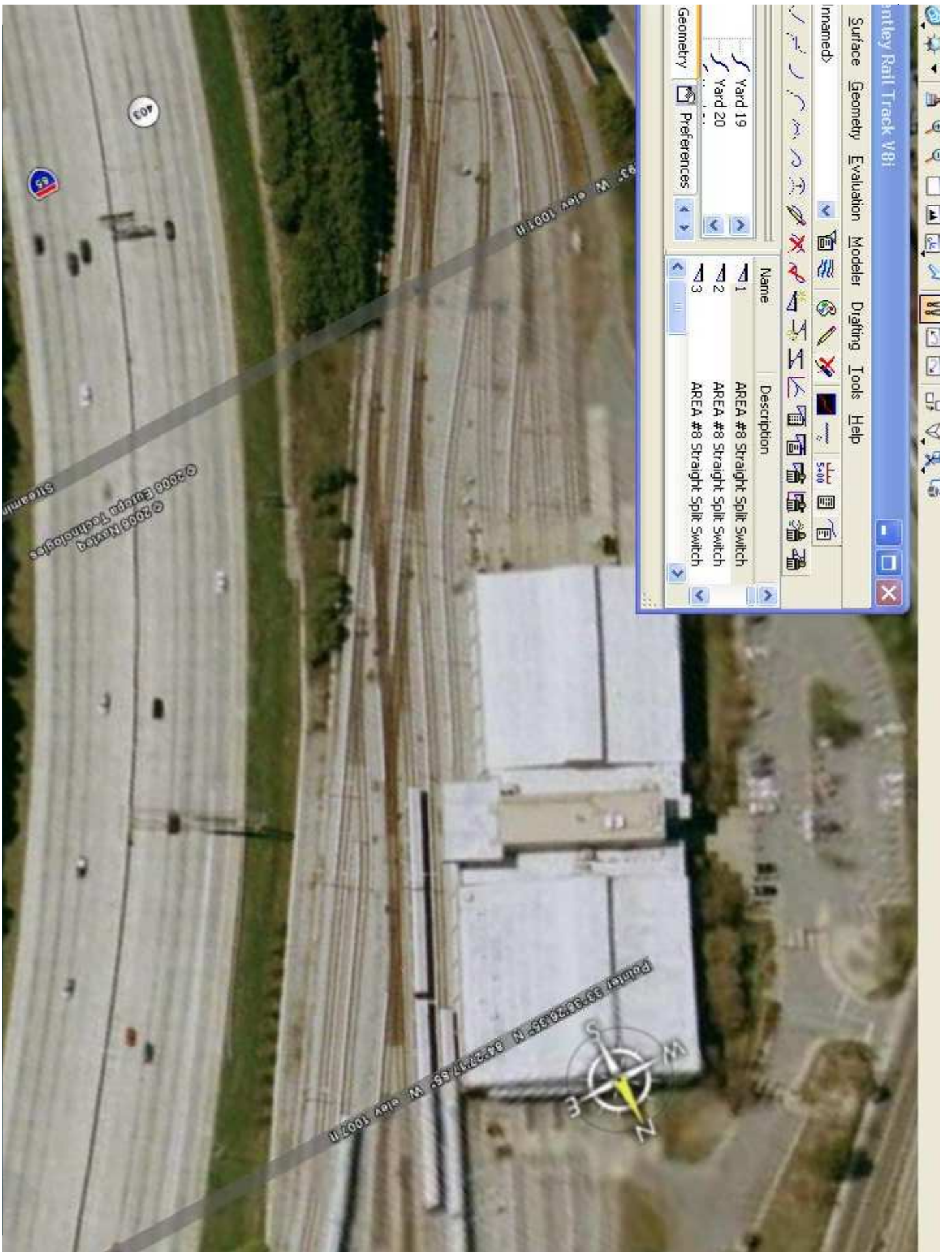
Element Type	Length	Starting Radius	Stopping Radius
Circular	41.570616	500.000000	500.000000

Buttons: Apply, Close, New..., Copy..., Delete, Rename..., Verify, Schematic, Help, Add..., Edit..., Delete

Example: Re-connecting turnouts

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





Penley Rail Track Y81

Surface Geometry Evaluation Modeler Drafting Tools Help

Innamed >

Yard 19
Yard 20

Geometry Preferences

Name Description

1 AREA #8 Straight Split Switch

2 AREA #8 Straight Split Switch

3 AREA #8 Straight Split Switch

93° W elev 1001-ft

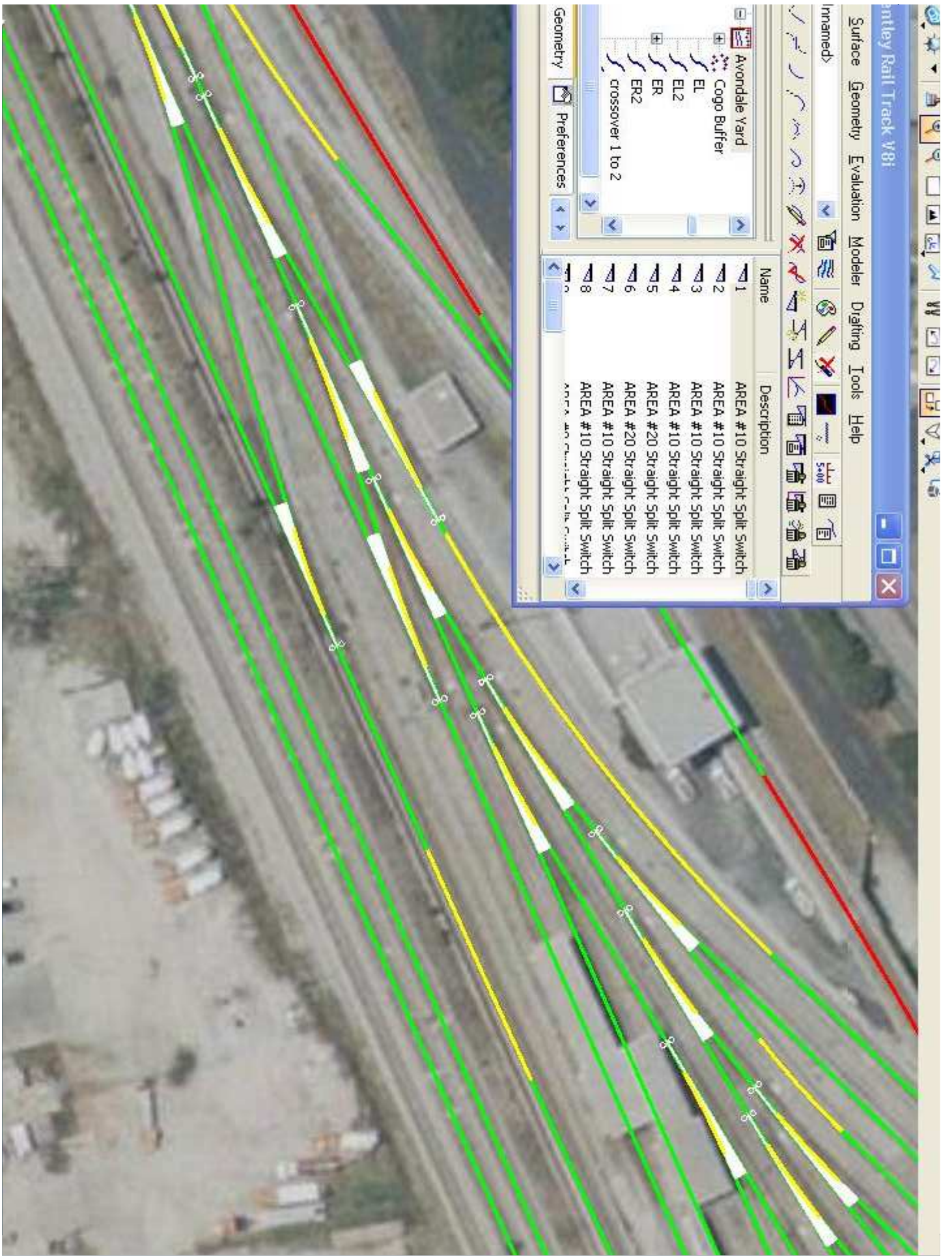
Point1: 33°38'20.95" N 84°27'17.65" W elev 1007-ft



©2008 Bentley
©2006 Europa Technologies
Silearn

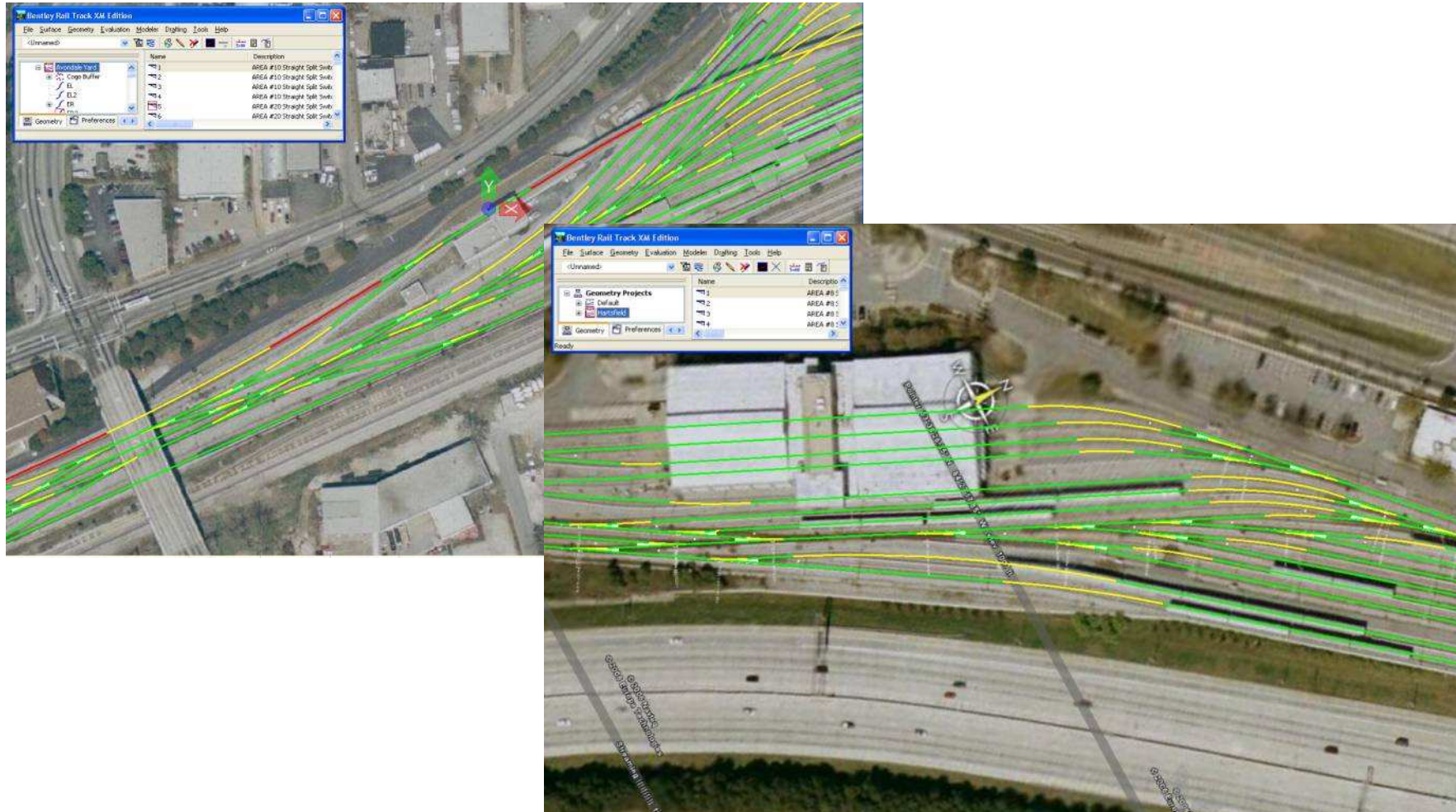
409





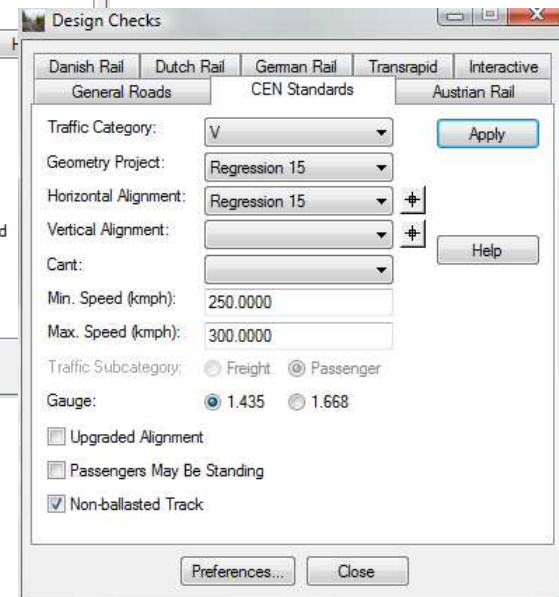
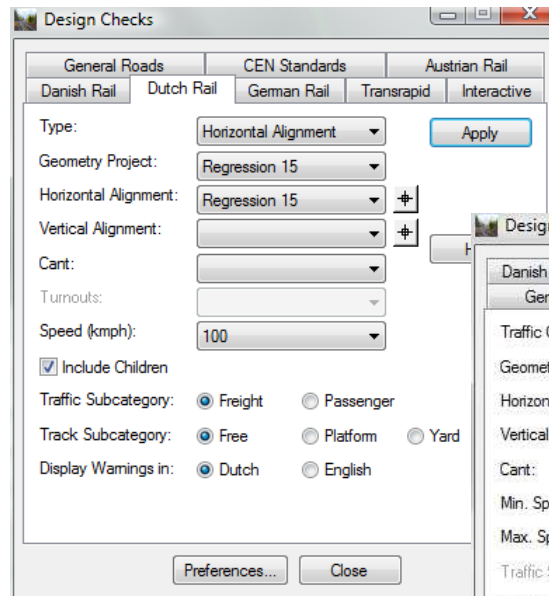
Name	Description
1	AREA #10 Straight Split Switch
2	AREA #10 Straight Split Switch
3	AREA #10 Straight Split Switch
4	AREA #10 Straight Split Switch
5	AREA #20 Straight Split Switch
6	AREA #20 Straight Split Switch
7	AREA #10 Straight Split Switch
8	AREA #10 Straight Split Switch

Resulting in models like these yards!



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

The screenshot shows the Bentley Rail Track XM Edition software interface. The main window displays an aerial view of a track layout with green and yellow lines. Two dialog boxes are open:

Display Turnouts in Profile

Profile Set: [Dropdown]
 Bottom Axis to Witness Line Offset: 10.0000
 Leader Line Length: 10.0000
 Drop Station Equation Names

Object	Prefix	Suffix	Precision	Format	Name
<input checked="" type="checkbox"/> Witness Line					tumout
<input checked="" type="checkbox"/> Leader Line					tumout
<input checked="" type="checkbox"/> Name					tumout
<input checked="" type="checkbox"/> Description					tumout
<input checked="" type="checkbox"/> .1 Station			0.12	ssss.ss	...
<input checked="" type="checkbox"/> .2 Station			0.12	ssss.ss	...

Display Turnouts

Object	Prefix	Suffix	Precision	Format	Name
<input type="checkbox"/> Turnout					...
<input type="checkbox"/> Recant Turnout					...
<input checked="" type="checkbox"/> In Vertical Curve					...
<input checked="" type="checkbox"/> Orphan Turnout					...
<input checked="" type="checkbox"/> Overlapping Turnout					...
<input type="checkbox"/> Name & Description					Rails
<input checked="" type="checkbox"/> .1 Station			0.12	ssss.ss	...
<input checked="" type="checkbox"/> .1 Point					...
<input type="checkbox"/> .0 Station			0.12	ssss.ss	...
<input type="checkbox"/> .0 Point					...
<input type="checkbox"/> .2 Point					...
<input type="checkbox"/> .3 Point					...
<input type="checkbox"/> S&C Nose & Crossing					Rails
<input type="checkbox"/> Shunt Point					...
<input type="checkbox"/> Equivalent Radii			0.12		Rails

Symbolize Unbent Turnouts Symbolize Bent Turnouts
 Drop Station Equation Names

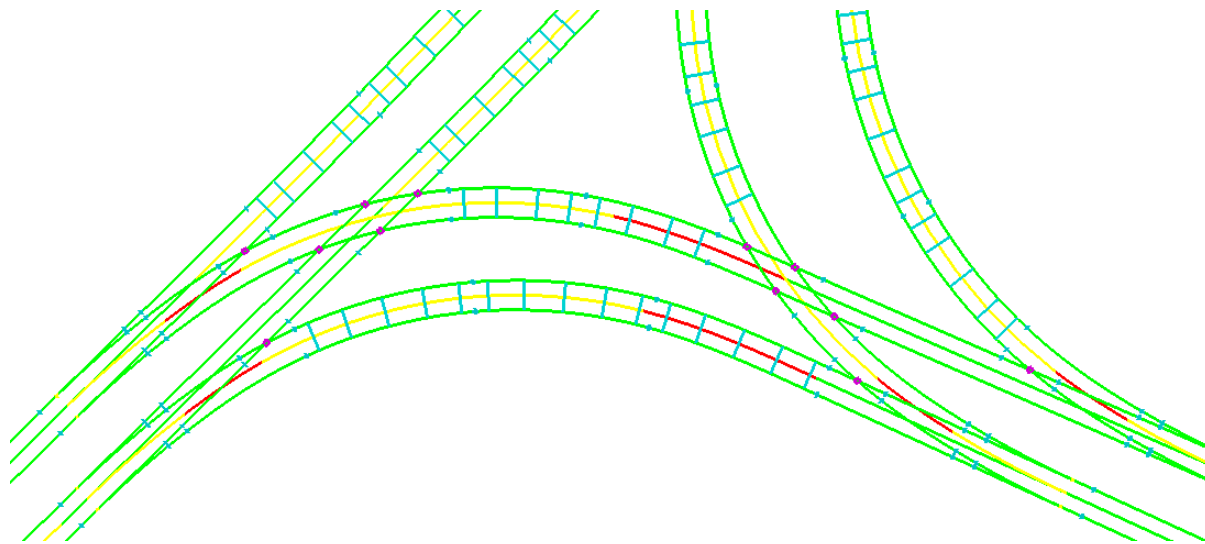
Light Rail Design & Manufacturing

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



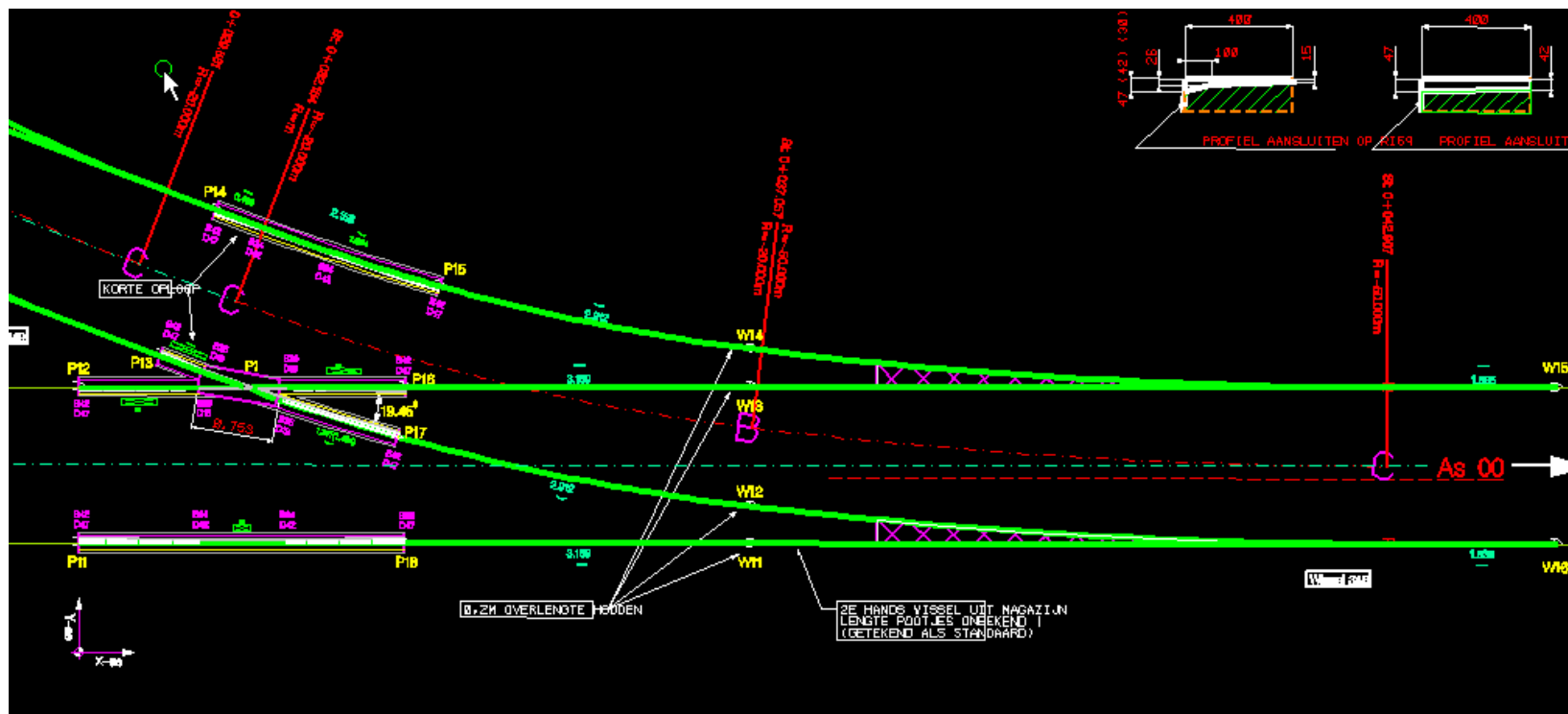
Light Rail Model

- 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



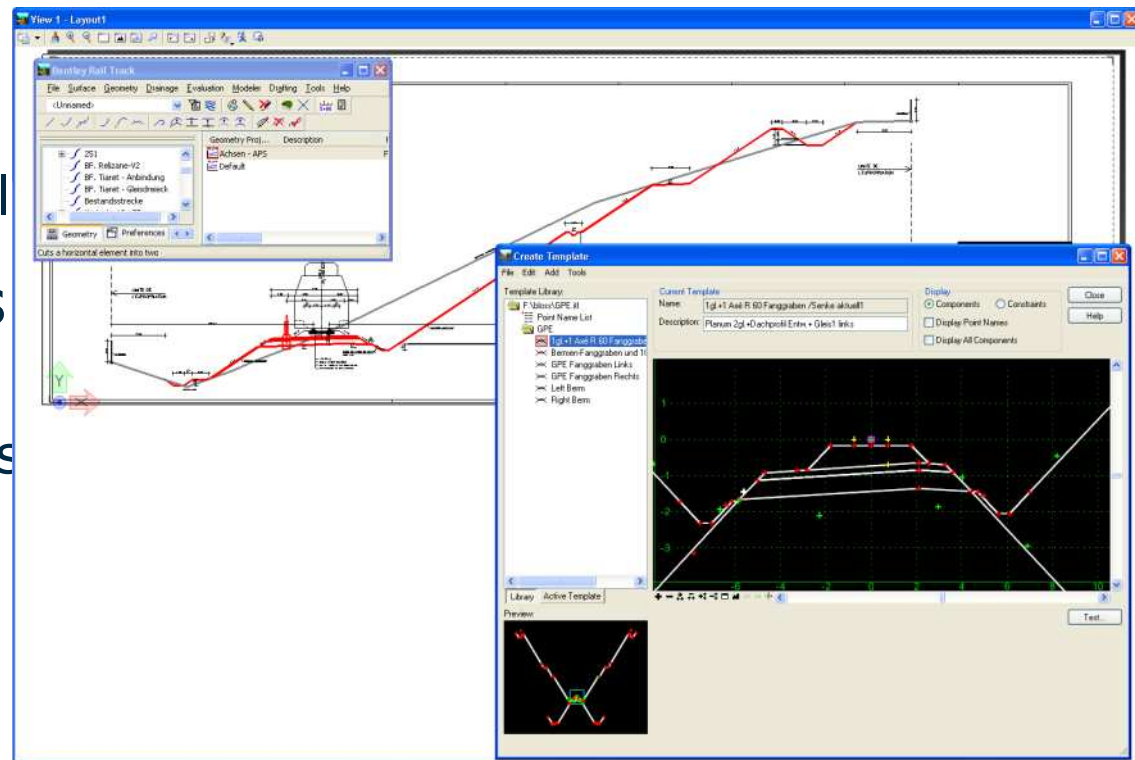
Maglev

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

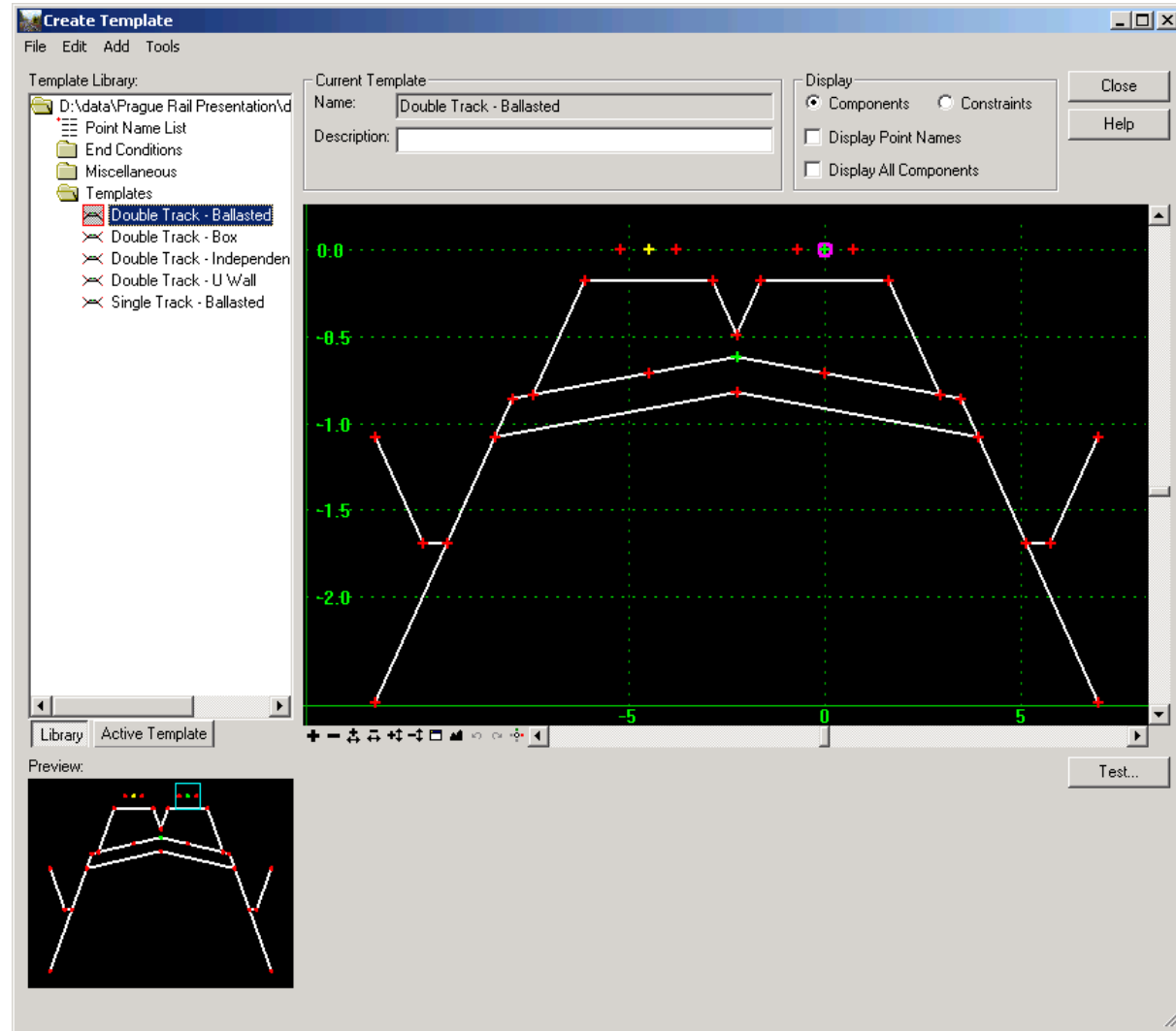


Earthwork Modeling & Templates

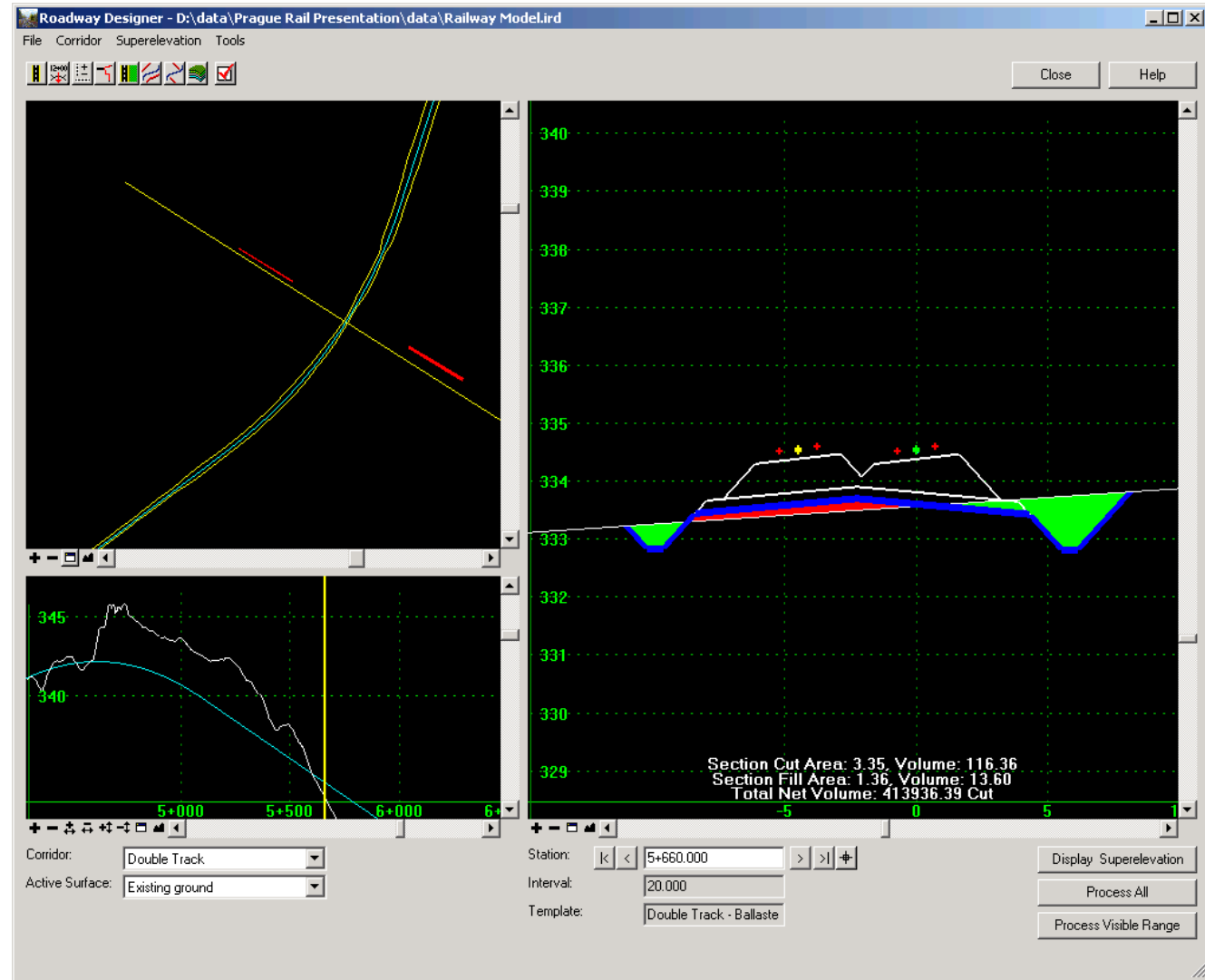
- Components
 - Closed shapes that represent materials
 - Rails & sleepers
 - Ballast
 - Subballast
 - Other material
- End conditions
 - Ditches
 - Cut / fill slopes



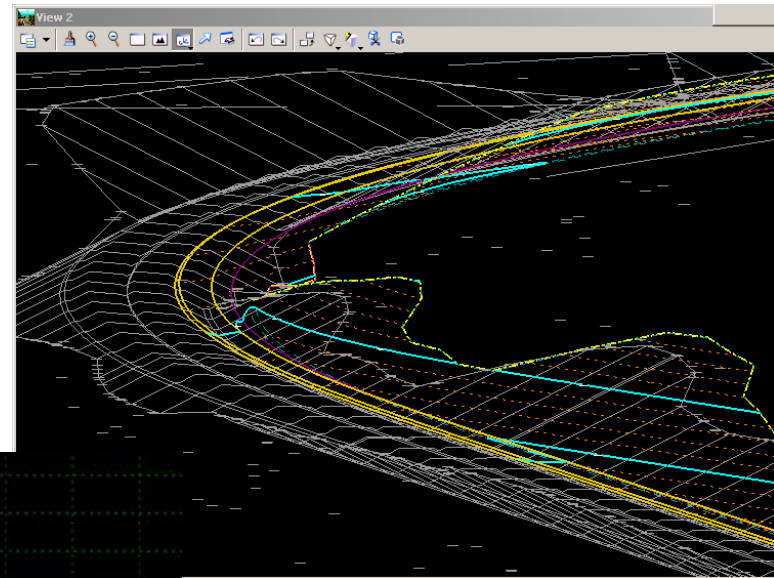
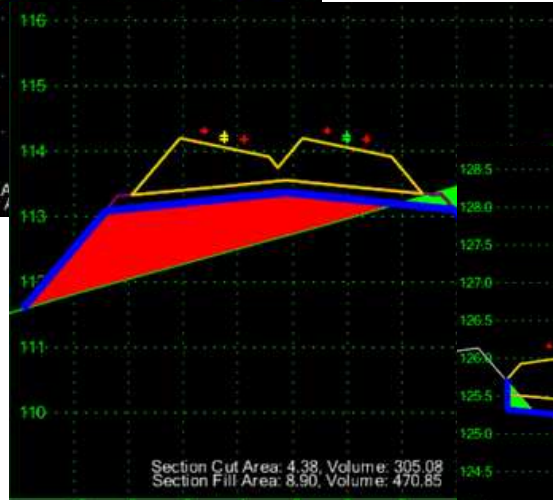
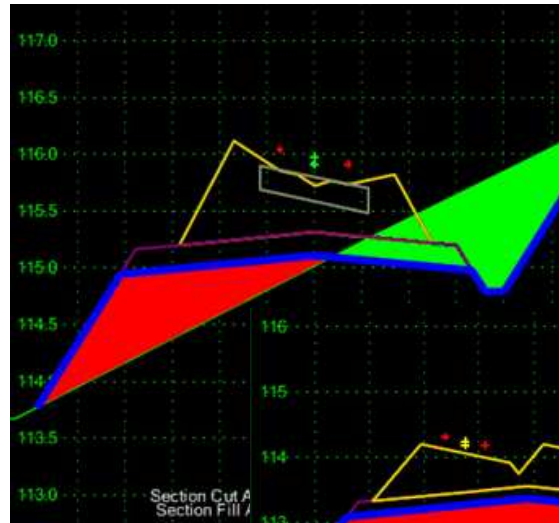
Create Template with Ballasted Section



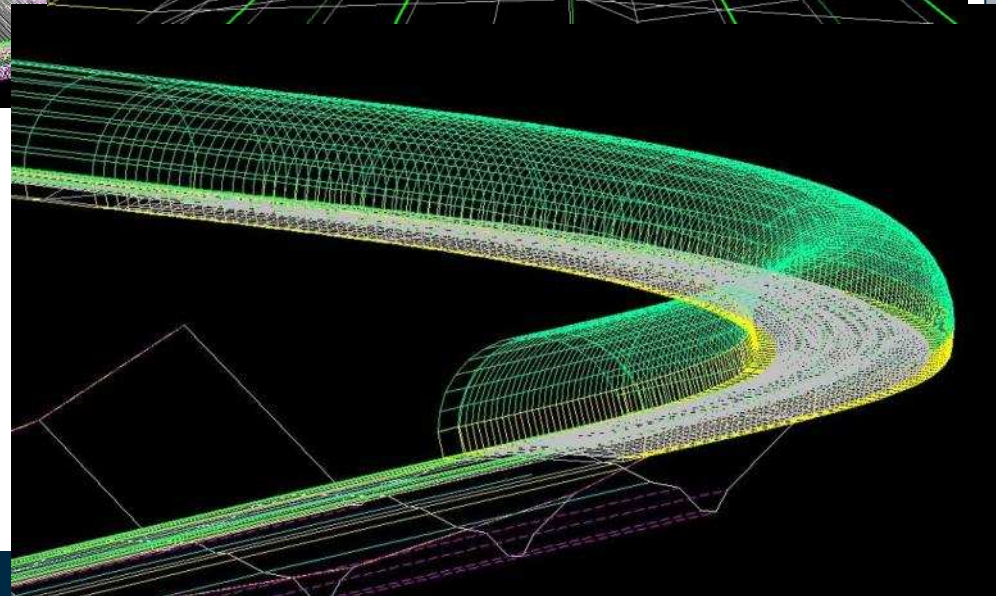
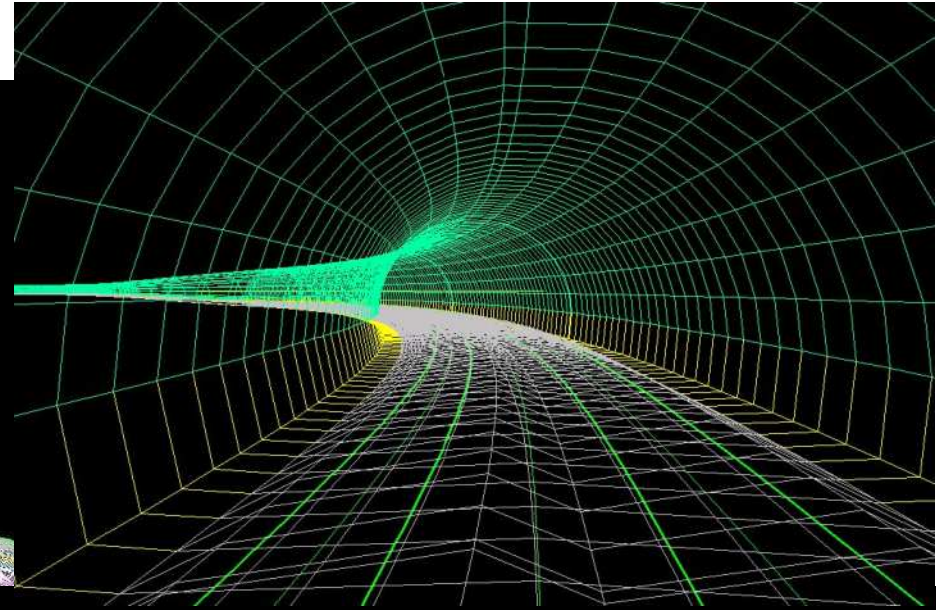
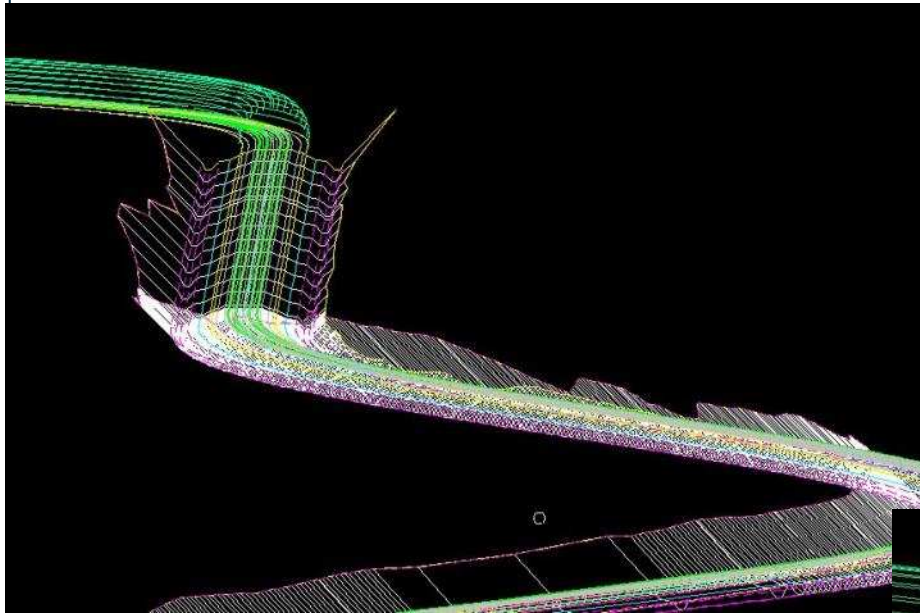
Roadway Design with Railway Template



Easily create track models...

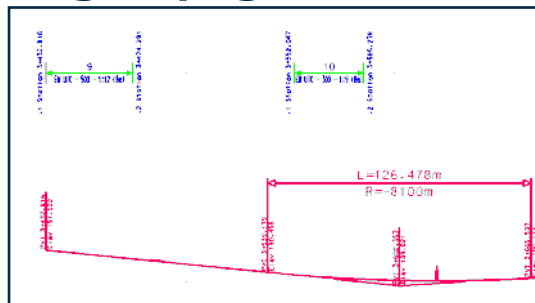


Easily create tunnel models....



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

Bentley InRoads Report Browser - C:\DOCUME~1\teds\LOCALS~1\Temp\RP7AD.xml

File Tools Help

d:\PROGRA~1\Bentley\INROAD~1.8\XML

Geometry

- Area.xml
- ControlLineData.xml
- HorizontalAlignmentAndEvents.xml
- HorizontalAlignmentCurveSetRev
- HorizontalAlignmentData.xml
- HorizontalAlignmentLengths.xml
- HorizontalAlignmentReview.xml
- HorizontalAlignmentReviewASCII
- HorizontalAlignmentSuperelevation
- HorizontalAndVerticalAlignmentRe
- HorizontalElementsTable.xml
- HorizontalElementsXYZ.xml
- HorizontalEvents.xml
- ListCoordinates.xml
- ListCoordinatesStation.xml
- ProfileStationElevation.xml
- ProfileStationElevationASCII.xml
- ProjectAlignmentListing.xml
- ProjectAlignmentListingDetails.xml
- SettingOutTable.xml
- SlewDiagram.xml
- SlewDiagramLegacyFormat.xml
- Traverse.xml
- TraversePoints.xml
- VerticalAlignment3PercentGrade.
- VerticalAlignmentAndEvents.xml
- VerticalAlignmentReview.xml
- VerticalAlignmentReviewASCII.xml
- VerticalAlignmentSightDistanceRe
- VerticalEvents.xml
- VerticalSlewDiagram.xml

ICS

Images

LegalDescription

LightRailManufacturing

RoadwayDesign

Schemas

Stakeout

StationOffset

Superelevation

Surfaces

Survey

Tabling

TemplateLibrary

Horizontal Alignment Review Report

Report Created: 7/13/2006
Time: 2:57pm

Project: Default

Description:

File Name:

Last Revised: ted.stephens 13/07/2006 14:36:35

Input Grid Factor: 1.00000000 **Note:** All units in this report are in meters unless specified otherwise.

Alignment Name: 1

Alignment Description:

Alignment Style: Default

		Station	Northing	Easting
Element: Linear				
	POB ()	0+00.000	292571.792	91478.052
	PI ()	1+71.799	292613.881	91644.616
	Tangential Direction:	N 75°49'08.00" E		
	Tangential Length:	171.799		
Element: Linear				
	PI ()	1+71.799	292613.881	91644.616
	PI ()	2+91.035	292578.061	91758.344
	Tangential Direction:	S 72°31'03.45" E		
	Tangential Length:	119.236		
Element: Linear				
	PI ()	2+91.035	292578.061	91758.344
	POE ()	4+54.804	292619.254	91916.848
	Tangential Direction:	N 75°25'54.65" E		
	Tangential Length:	163.769		

Data Export

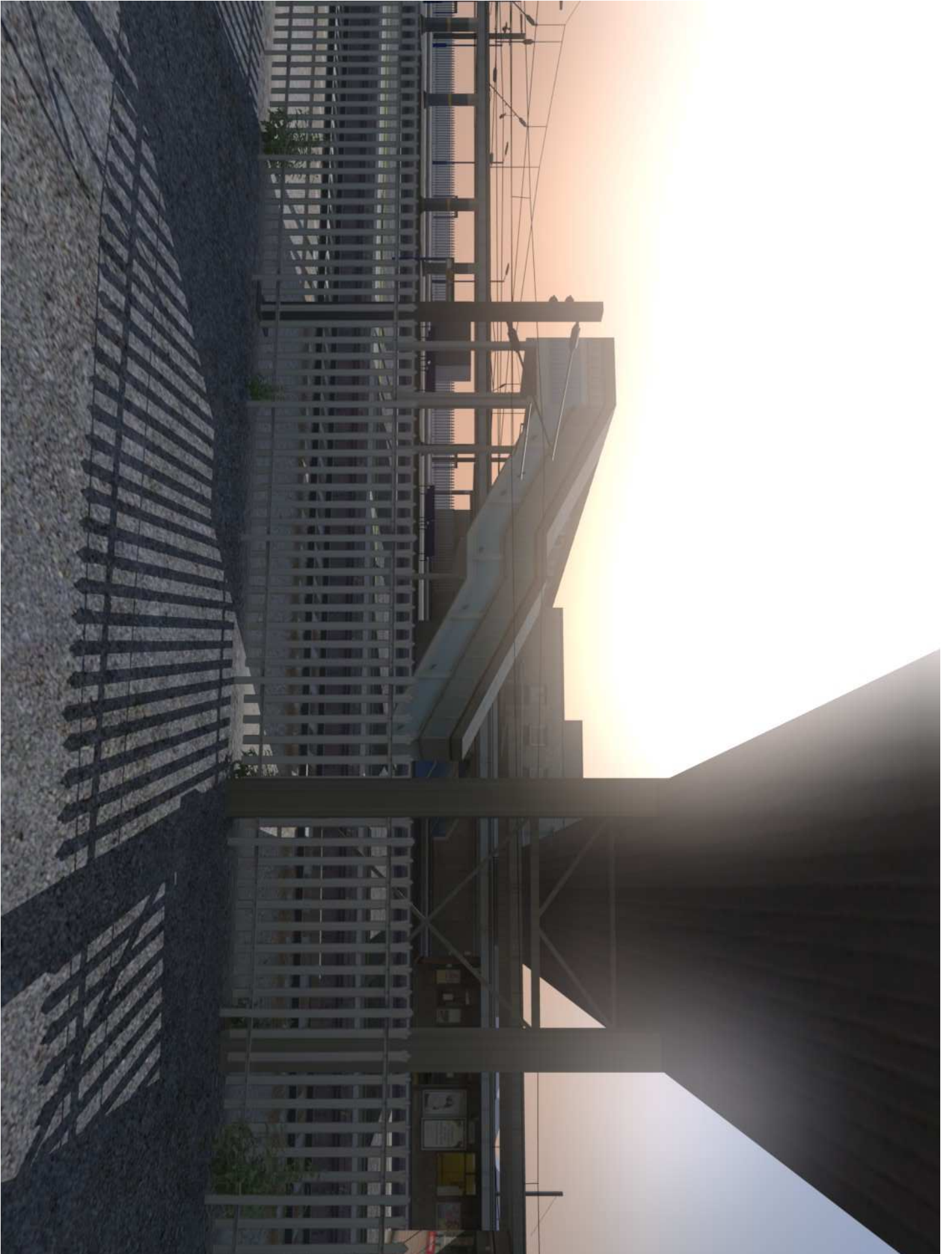
- LandXML
 - Geometry and surface models
- Instrumentation
 - Trimble
 - Leica
- Tamping Machines
 - Plasser & Theurer – WinALC format
 - Matisa – PALAS format

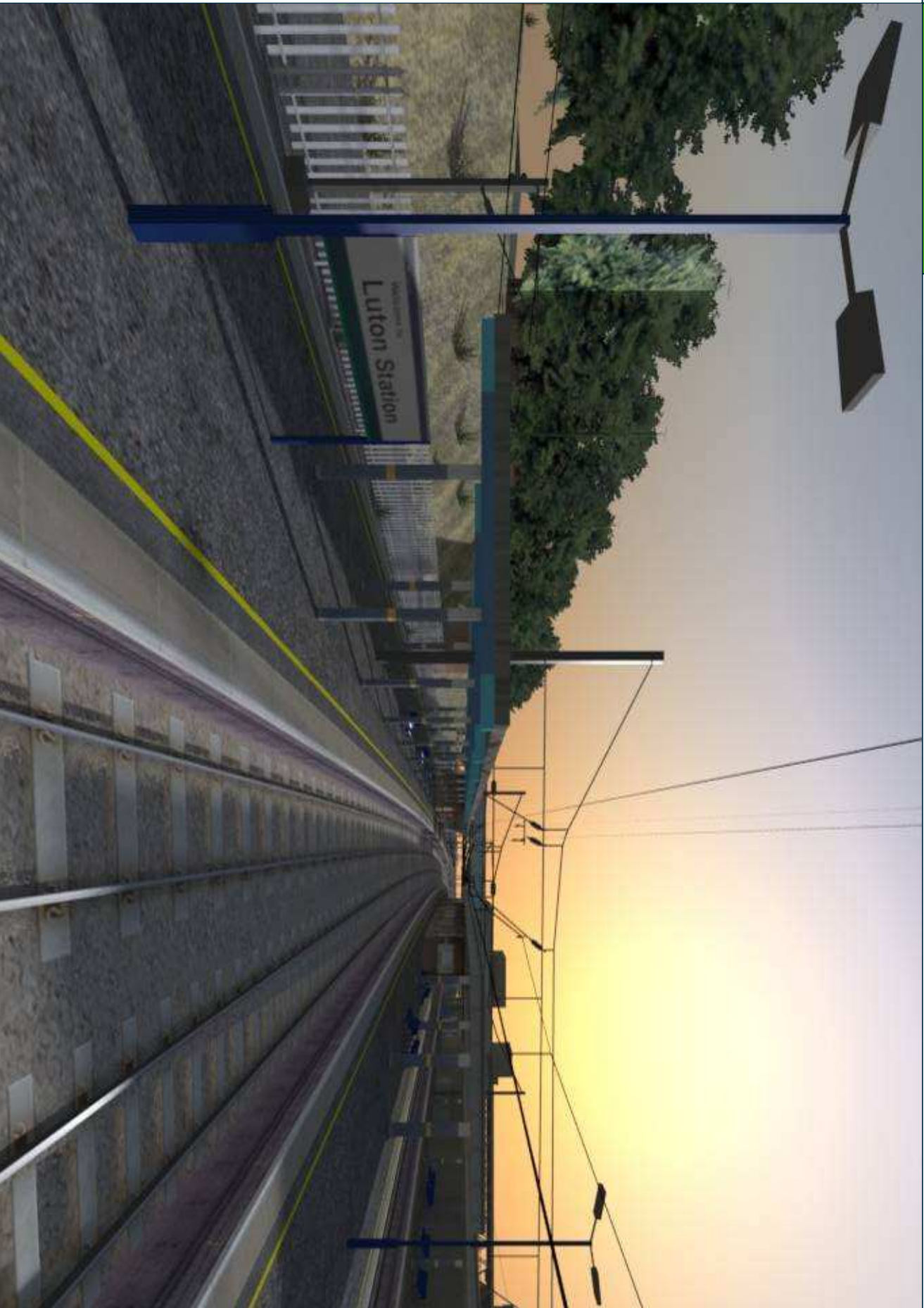


Rendered images and VR

Direct creation of images and VR models using MicroStation.







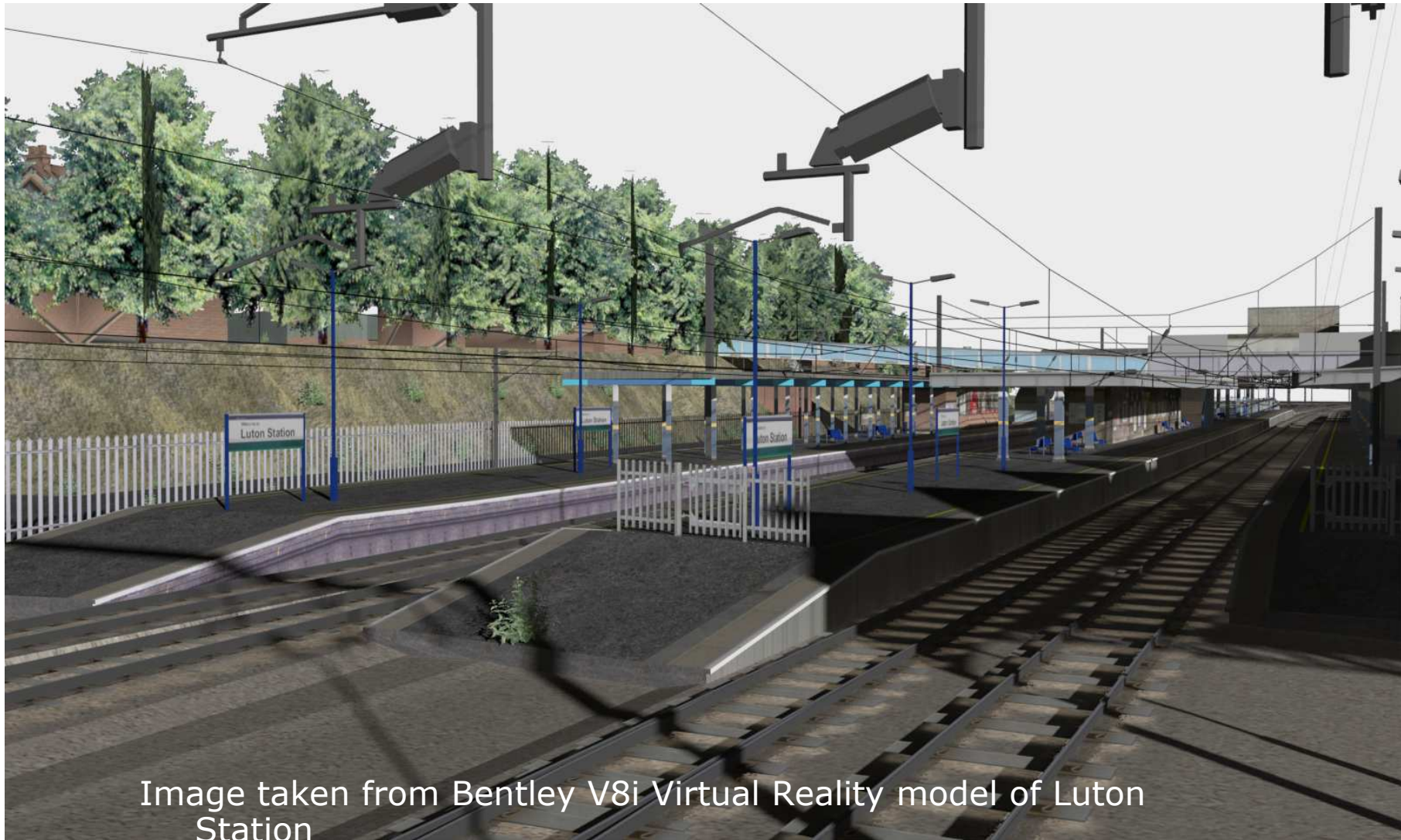


Image taken from Bentley V8i Virtual Reality model of Luton Station



Bentley Rail Track

For more information,
please visit:

www.bentley.com