Bentley Rail Track Update

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www.bentley.com

bentleyuser.dk
BENTLEY USER GROUP DENMARK

2002 2003 2004 2005
TMC - DIB
User Group Denmark
Working together

Recent Past and Near Future

- Today, I will discuss recent enhancements to **Bentley Rail Track**. Some of these enhancements you may be very familiar with and others you may not be aware of.

- Also, I will discuss the development of **Power Rail Overhead Line** that will be available later this year. You may be unaware of this product, but hopefully when it is released later this year, it will become another product that you will use on your projects!
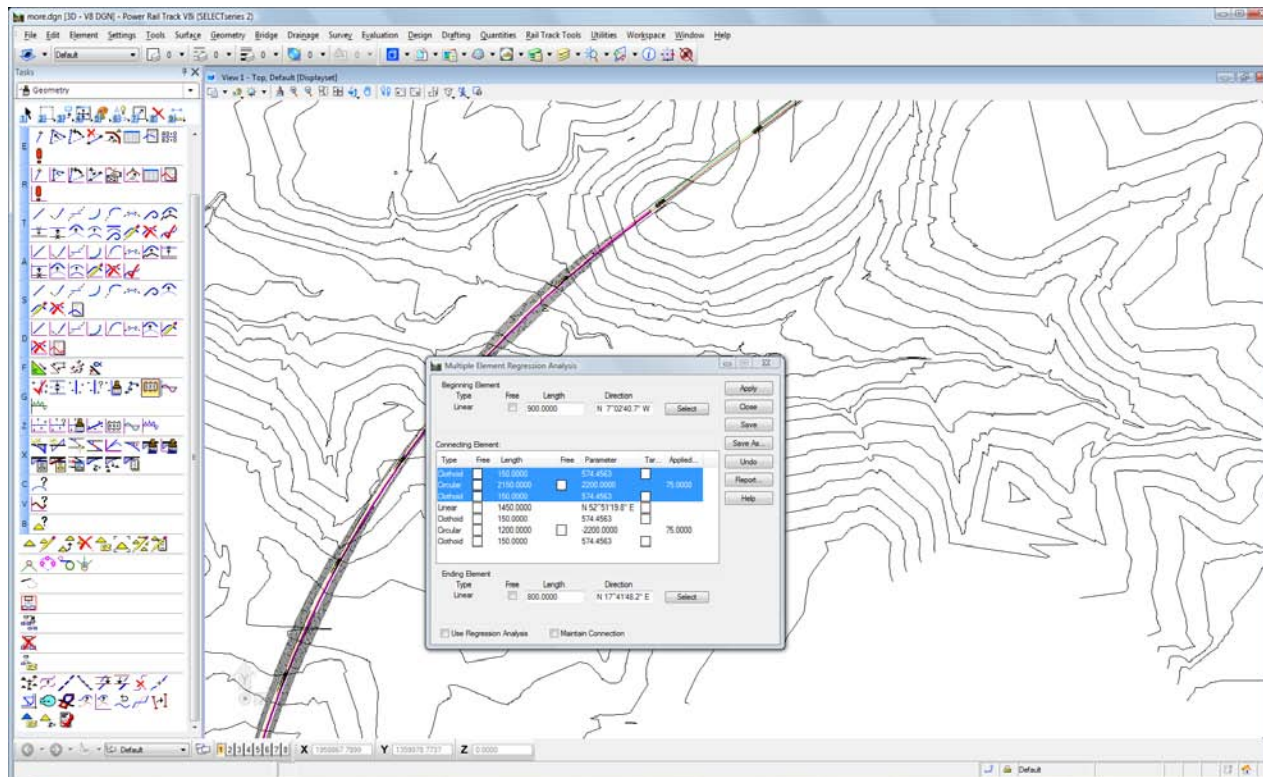
Roads and Bridges

Bentley

New Product *Power Rail Track V8i*

- Similar to **Power InRoads** & **Power GEOPAK**

- **Power Rail Track** includes
  - **Bentley Rail Track Suite** functionality (everything!)
  - Data Acquisition
  - Map
  - Available in *SELECTseries 2* (i.e. now!)

Roads and Bridges
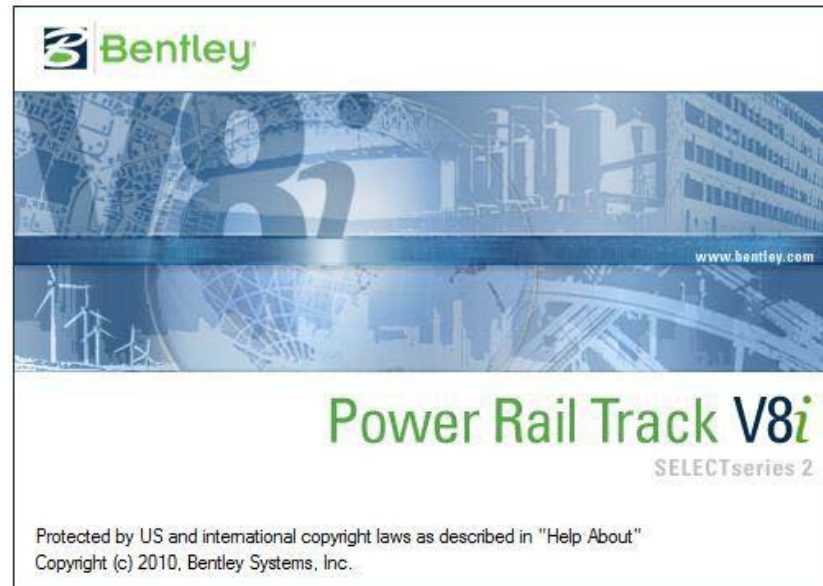
Power Rail Track V8*i*

- Interface is customizable with *common* tools
- Single menu & task bars

Roads and Bridges

Background

Just a bit of background on **Bentley Rail Track**

Roads and Bridges

Bentley

Bentley Rail Track is a Global Solution!

- **Bentley Rail Track** is suitable for designing
  - Light rail
  - Heavy rail
  - High-speed rail
    - Steel on steel or magnetic levitation systems

- **Bentley Rail Track** has been internationalized & localized
  - Available in English, German, Spanish, Chinese, Russia, Italian plus other languages
  - Deliver standard turnouts
  - Build in railway specific design checking

Bentley

Bentley Rail Track offers…

- Horizontal & vertical alignment design
  - New design
  - Single and multi-element regression analysis for maintenance / renewals

- Cant / superelevation design

- Turnouts
  - Specialized geometry

- Also includes *specialized* toolsets for
  - Design checking
  - Field to design / Design to field
    - *Machine* to *design* to *machine*
  - Light rail manufacturing
  - Magnetic levitation

Roads and Bridges

Bentley

Alignment Enhancements

Horizontal and vertical alignment enhancements for rail design

Roads and Bridges

View Options

- Update annotation as the geometry is created / edited
  - Based upon
    - Alignment's style
    - Persisted command's preferences
  - Allows different "type of alignments" to display differently
    - A <u>road baseline</u> would have:
      - Horizontal annotation
      - Stationing
      - Curve set annotation
    - A <u>right of way take</u> would have:
      - Horizontal annotation
    - A <u>track</u> would have:
      - Regression Points
      - Horizontal annotation
      - Stationing

Geometry Options

- ☑ Annotate Horizontal Elements
- ☐ Annotate Vertical Elements
- ☐ Annotate Closed Areas
- ☑ Annotate Stationing
- ☐ Annotate Curve Sets
- ☐ Annotate Vertical Change in Plan
- ☐ Annotate Regression Points

Apply

Close

Preferences...

Help

Bentley
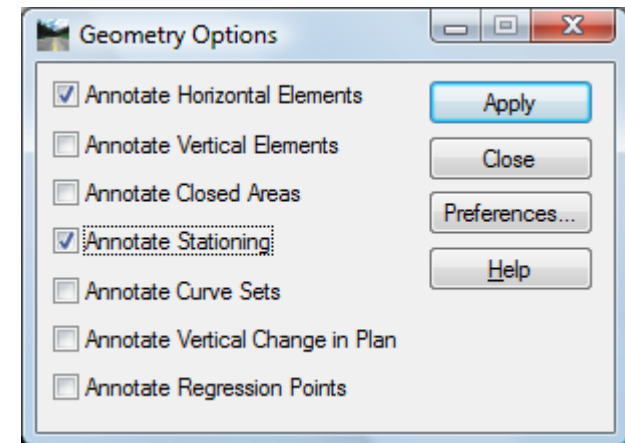
Simplified Horizontal Elements

- *Horizontal Elements* <u>without</u> dialogs
  - Well, there is a *Settings* dialog, which defines the radius and optional spiral lengths!
    - This dialog is active even during graphics input
  - *Add Fixed*, *Float* and *Free* elements
  - *Move*
  - *Edit*
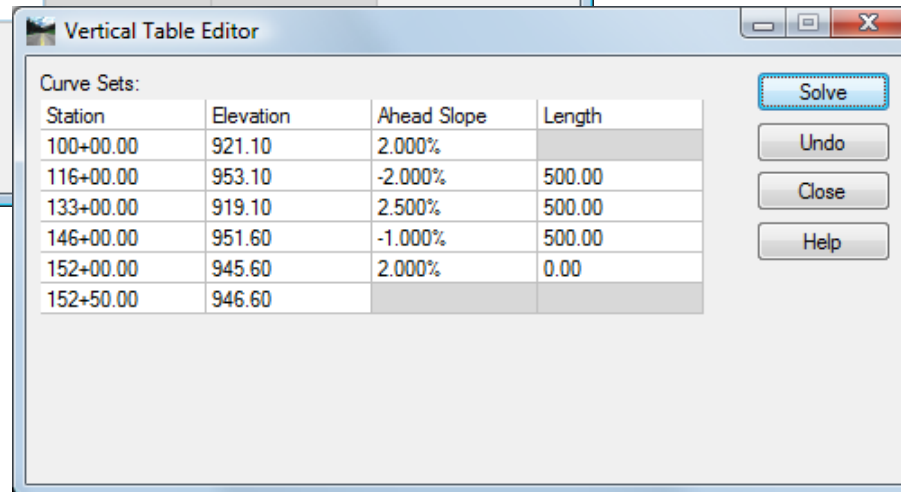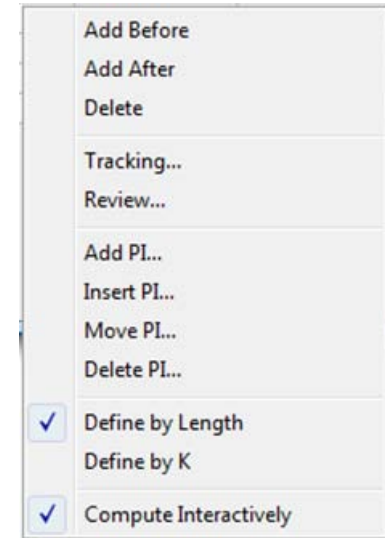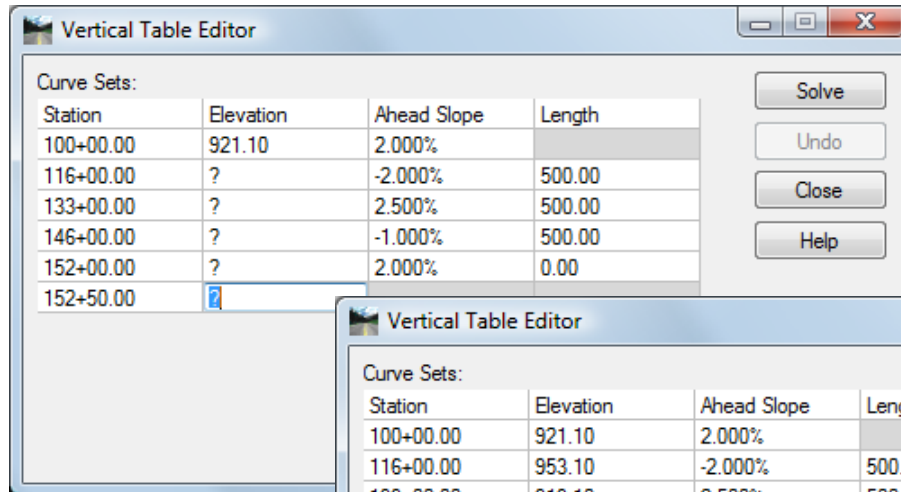 - *Delete*
  - MicroStation only functionality!

Roads and Bridges
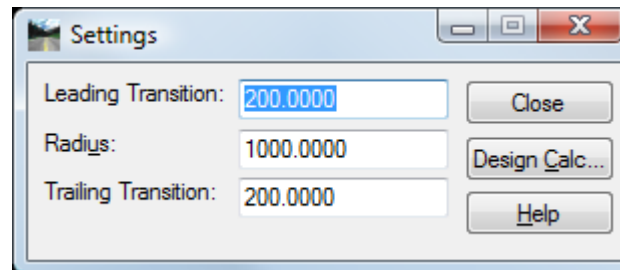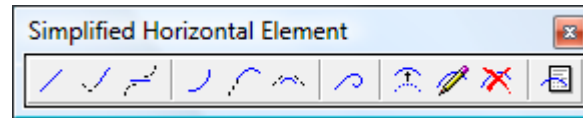
Horizontal Design Criteria

- ## Curve Set Based
  - *Add PI & Insert PI*

- ## Looks up radius based upon speed / maximum superelevation
  - ..\data\metric\Horizontal Design Checks.txt
  - *Primarily road oriented but <u>this could be enhanced for rail</u>*
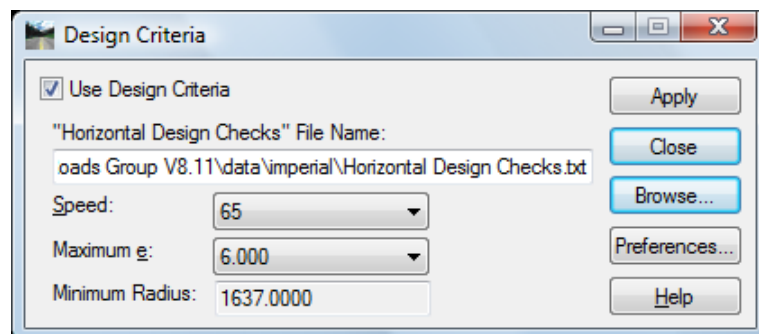
DESIGN SPEED	MAXIMUM E	MAXIMUM F	MINIMUM RADIUS
20.	.04	.17	127.
30.	.04	.16	302.
40.	.04	.15	573.
50.	.04	.14	955.
55.	.04	.13	1186.
60.	.04	.12	1528.
20.	.06	.17	116.
30.	.06	.16	273.
40.	.06	.15	509.
50.	.06	.14	849.
55.	.06	.13	1061.
60.	.06	.12	1348.
65.	.06	.11	1637.
70.	.06	.10	2083.

Horizontal Table Editor

- Invokes *Add*, *Insert*, *Move* and *Delete PI* commands

- *Redesign All*
  - Based up *Horizontal Design Criteria*
  - Either invoke the *Horizontal Design Criteria* command or <Ctrl> right click and change the speed and / or maximum superelevation

Roads and Bridges

Simplified Vertical Elements

- *Vertical Elements* without dialogs
  - Well, there is a *Settings* dialog, which defines the K or length of curve!
    - This dialog is active even during graphics input
  - *Add Fixed*, *Float* and *Free* elements
  - *Move*
  - *Edit*
  - *Delete*
  - MicroStation only functionality!

Roads and Bridges

Bentley
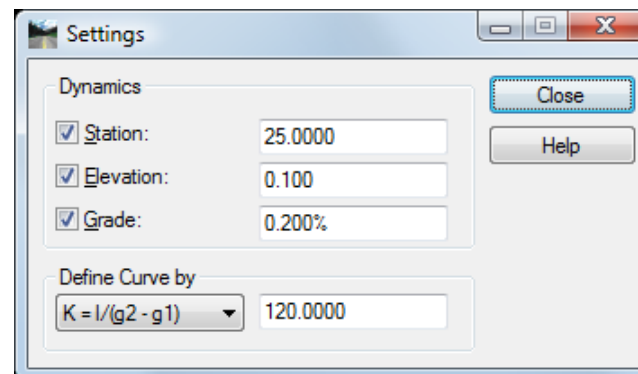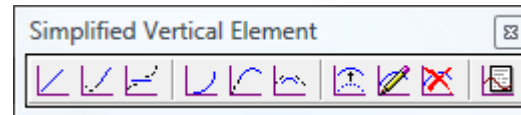
Vertical Design Criteria

- ## Curve Set Based
  - *Add PI & Insert PI*

- ## Looks up K based upon speed / lower or upper limits
  - ..\data\imperial\Vertical Design Checks.txt
  - *Primarily road oriented but <u>this could be enhanced for rail</u>*
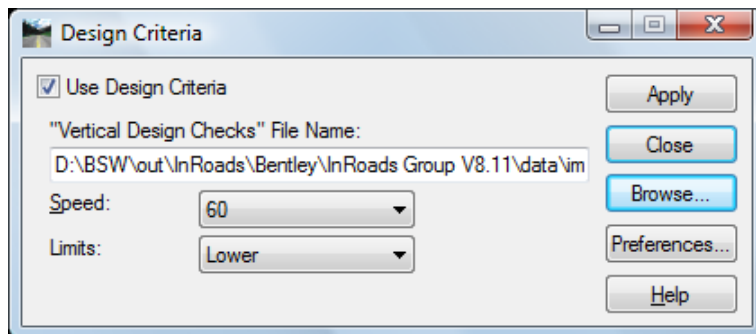
| DESIGN | | Crest – Upper | | Crest – Lower | | Sag – Upper | | Sag – Lower | | Passing Sight Dist. | |
| | | Stop | K | Stop | K | Stop | K | Stop | K | Minimum | K |
	f	Dist	Value	Dist	Value	Dist	Value	Dist	Value	Dist	Value
	.40	125.	10.	125.	10.	125.	20.	125.	20.	800.	210.
	.38	150.	20.	150.	20.	150.	30.	150.	30.	950.	300.
30.	.35	200.	30.	200.	30.	200.	40.	200.	40.	1100.	400.
35.	.34	250.	50.	225.	40.	250.	50.	250.	50.	1300.	550.
40.	.32	325.	80.	275.	60.	325.	70.	275.	60.	1500.	730.
45.	.31	400.	120.	325.	80.	400.	90.	325.	70.	1650.	890.
50.	.30	475.	160.	400.	110.	475.	110.	400.	90.	1800.	1050.
55.	.30	550.	220.	450.	150.	550.	130.	450.	100.	1950.	1230.
60.	.29	650.	310.	525.	190.	650.	160.	525.	120.	2100.	1430.
65.	.29	725.	400.	550.	230.	725.	180.	550.	130.	2300.	1720.
70.	.28	850.	540.	625.	290.	850.	220.	625.	150.	2500.	2030.

Roads and Bridges

Vertical Table Editor

- ## Two modes
  - *Compute Interactively*
  - Or wait and *Solve* for unknown values

Roads and Bridges

Vertical Table Editor

- Invokes *Add*, *Insert*, *Move* and *Delete PI* commands

- *Redesign All*
  - Based upon *Vertical Design Criteria*
  - Either invoke the *Vertical Design Criteria* command or <Ctrl> right click and change the speed and limits

Roads and Bridges
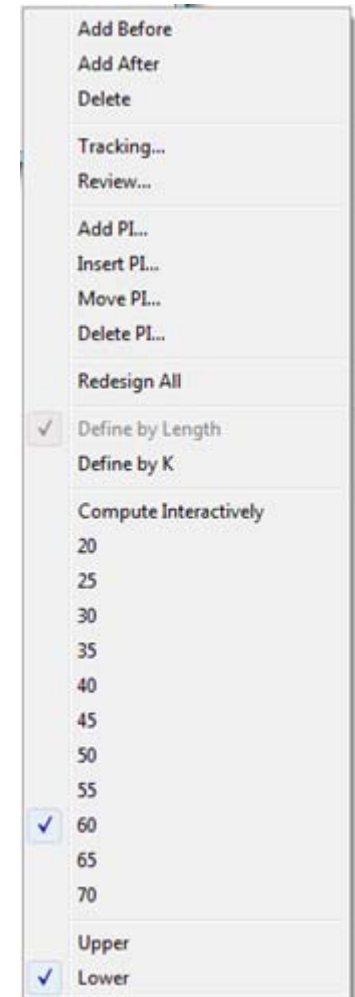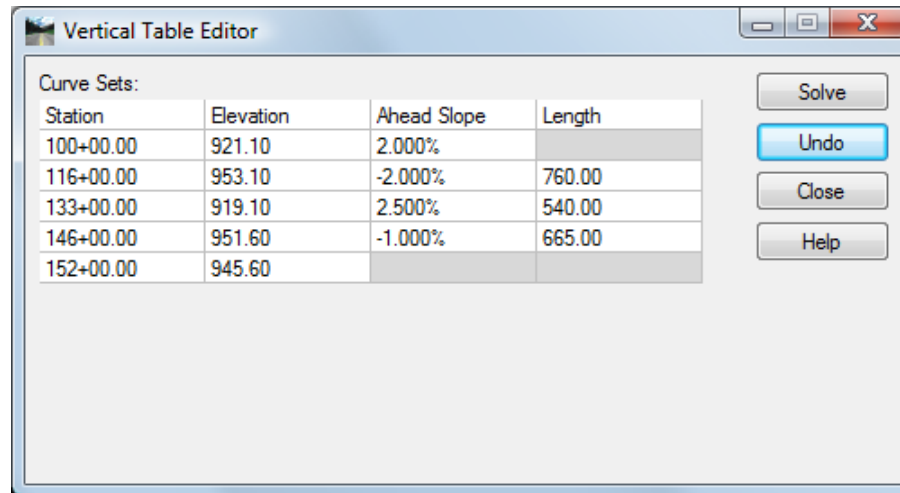
Vertical Healing

- Synchronize / update the vertical alignment when the horizontal alignment has changed
  - The coordinate position of vertical PI's will be held!
    - The user is responsible for potential overlaps
    - The user is responsible for resolving verticals that are beyond the limits of the horizontal
    - Set in *File > Project Options > Geometry*, but it is one of those settings that you should set and remain set!
  - *This is one implementation, others would have been possible!*

Roads and Bridges

Bentley

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 enhances the field data!

- Edit / review
  - Select / Regress, which is *heads-up selection / auto element type determination!*
    - Reduces potential user errors & time
  - *Quick Regression*

- Slew diagrams and reporting
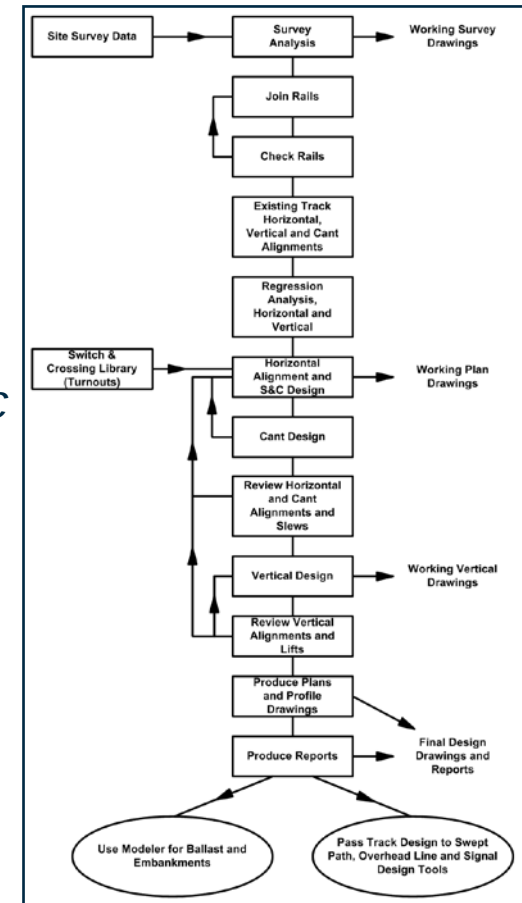
Quick Regression

- *Quick* horizontal regression
  - A first pass – automatic regression
    - Includes lines, circular arcs and spirals
    - Resolves long straights into multiple straights

- *Quick* vertical regression
  - Similar to horizontal
  - Includes a standard lift & a lines only option

Roads and Bridges
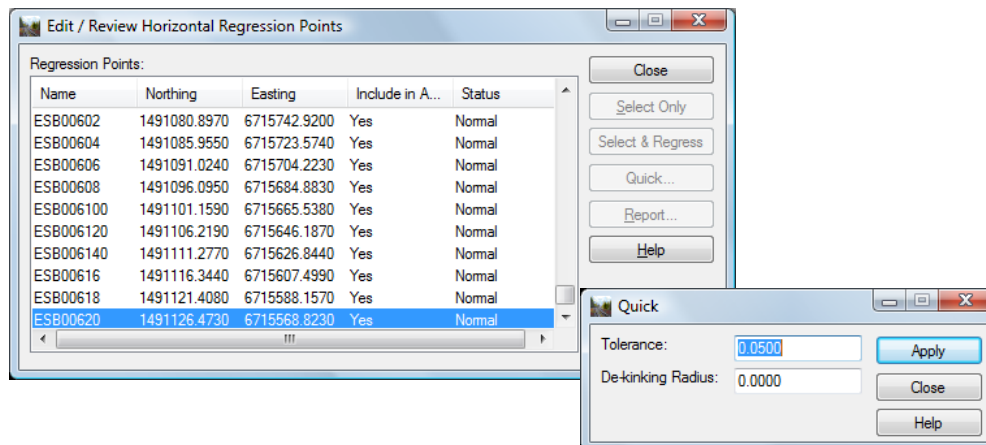
Single Element Regression Enhancement

- Single element regression with multiple alignments
  - Single element regress 2 or more alignments at once
  - Regressed elements will be parallel / concentric to each other
  - Different offsets for each set of elements

- Enabled by right-clicking in *Edit / Review Regression Points* list-view

- Automatically occurs with *Select & Regress* option

Cant / Superelevation Design

Specialized geometry for track cant / superelevation

Roads and Bridges

Cant / Superelevation

- ## Standard *international* railway terminology
  - Equilibrium cant, applied cant, cant deficiency, etc.
    - Imperial or metric units

- ## Calculations
  - Standard equilibrium equations that can be found in well known literature

Roads and Bridges

Integrated into Horizontal Design

- Radius & spiral lengths based upon cant
  - Cant & Speed are persisted with the horizontal elements
  - Suggests spiral lengths
    - Imperial & metric are slightly different
  - Enables design optimization
  - Mix transitions types

Roads and Bridges
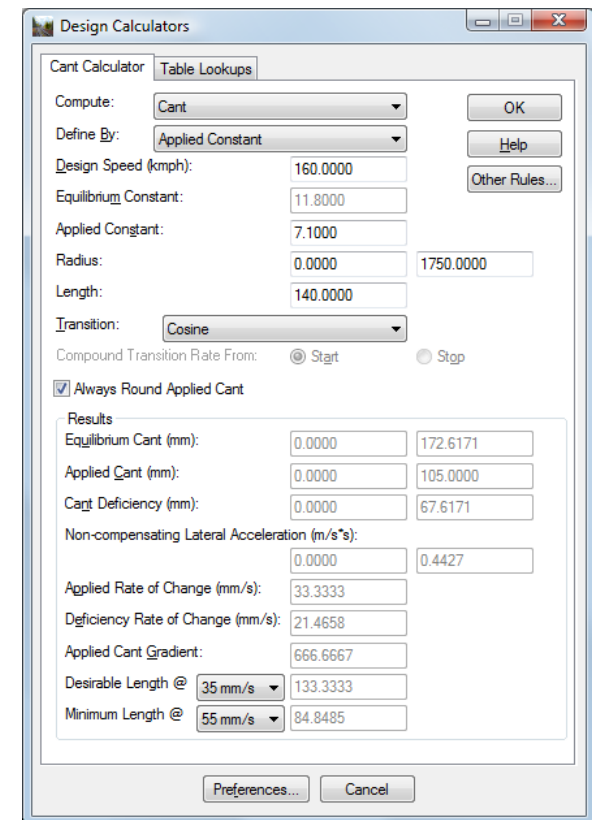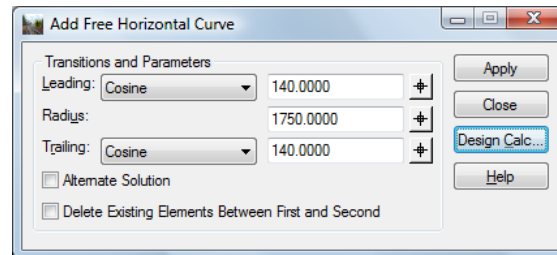
Cant Alignment Editor

- Creation based upon
  - Equilibrium equations
  - Alternate speed
  - User defined tables

Roads and Bridges

Other Cant Rules

- Integrating *other* rules into the system

Roads and Bridges
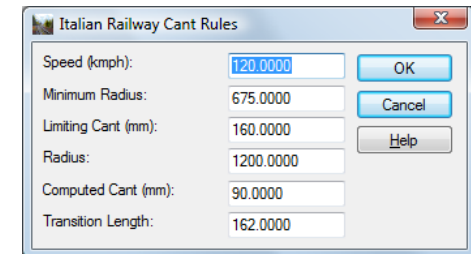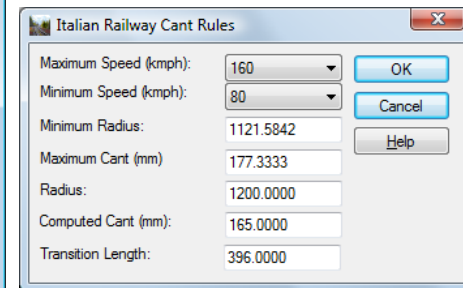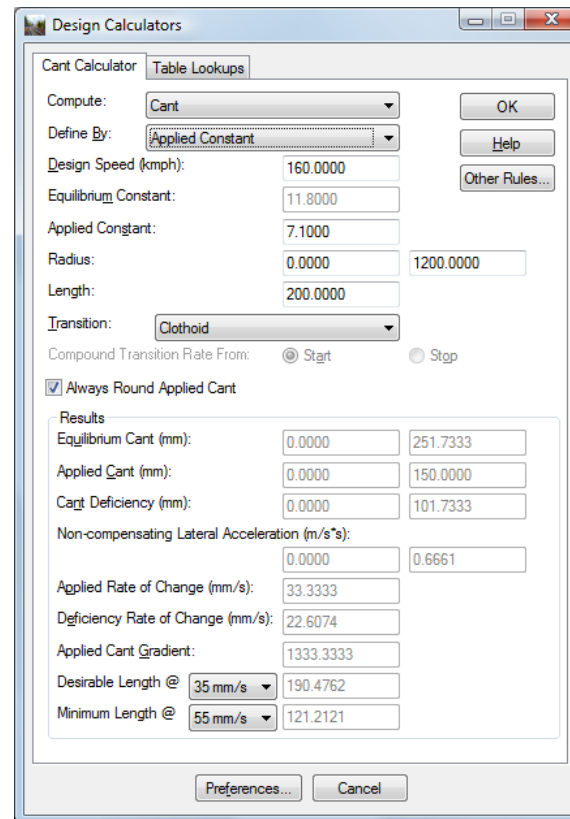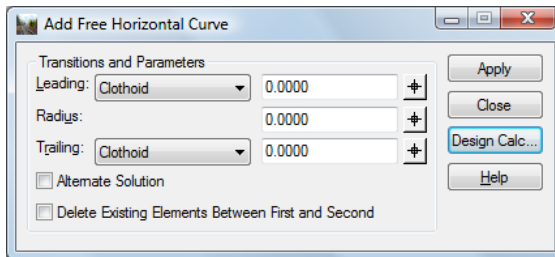
Turnouts

Specialized geometry that conforms to well defined bending rules

Turnouts

- ## Single, double and slips
  - Tangential and non-tangential turnouts

- ## Multiple bending / flexing methods to satisfy various industry standards!
  - Germany / Austrian
  - Swiss
  - UK

Roads and Bridges
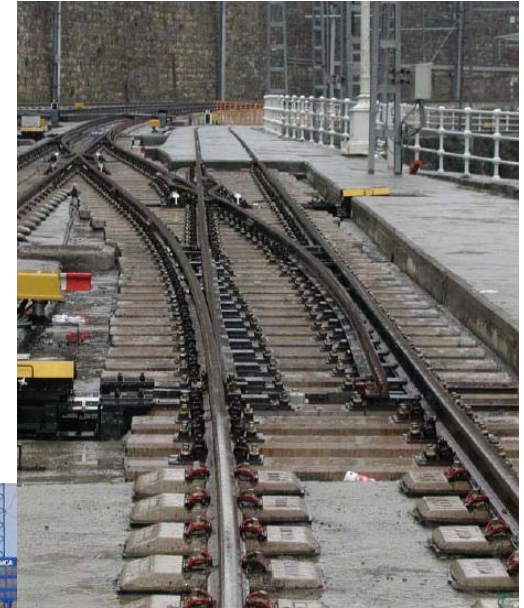
Turnout Library

- ## Typical Turnout Library Editor
  - ### Creation of typical turnouts (standards)
    - #### The software delivers various country standards
      - Danish Railways
      - Dutch Railways / ProRail
      - German (heavy & light rail)
      - Indian Railways
      - Russian Railways
      - Spanish (heavy & light rail)
      - Swiss Railways
      - UK (113A's & NR60's)
      - AREMA
      - Or we will help you to create them

Roads and Bridges

Turnout Connection Editor

- Used for more advanced geometric constructions
  - Crossovers
  - Sidings

- Editing an existing construction
  - Change type
  - Dynamically move

- Maintains *rules* and *relationships*!

- Do you see the GUI changes?

Roads and Bridges
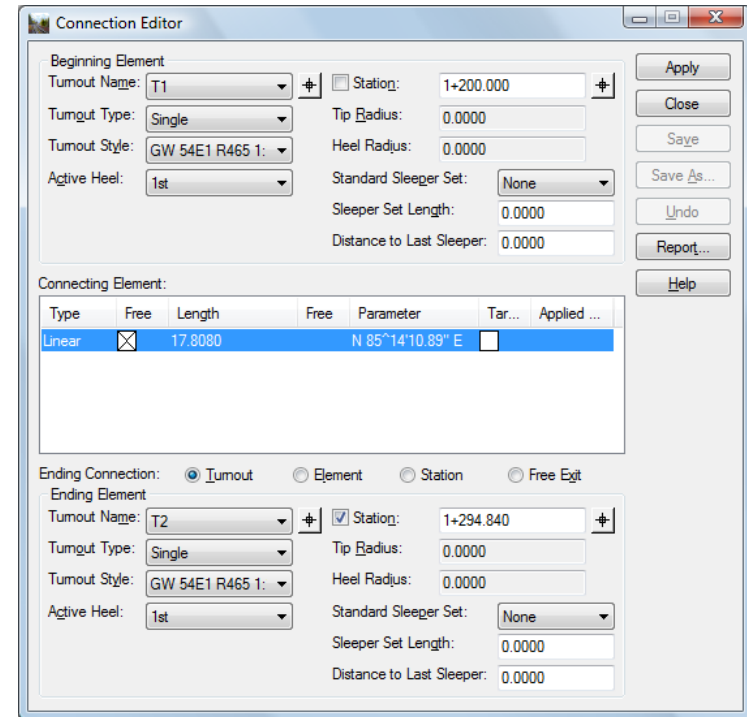
Design Checking

Detailed design checking based upon simple built-in rules to specific / comprehensive railway rules.

Built in Design Checking

- *Cant Alignment Editor* includes basic parameters for design checking

- Visual checking with *Display Turnouts*

Roads and Bridges
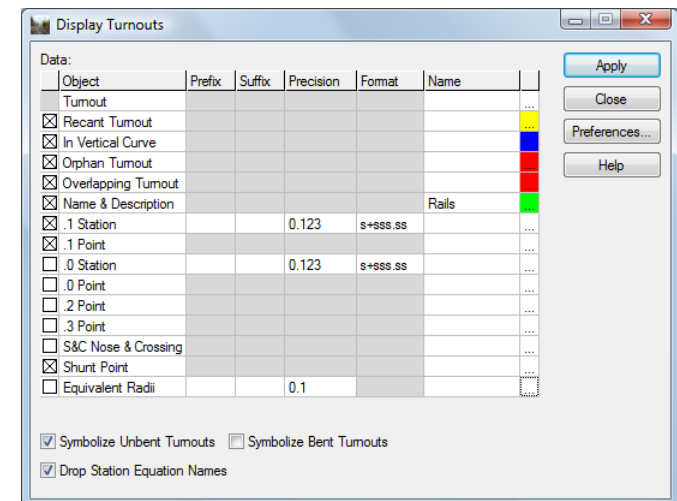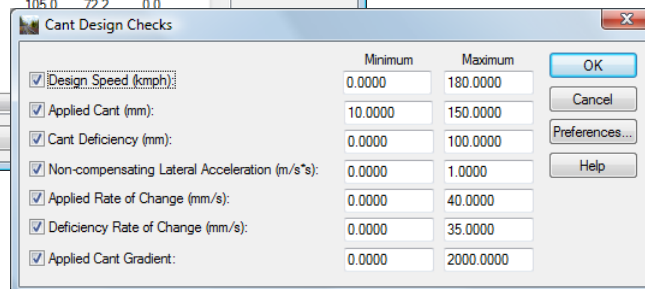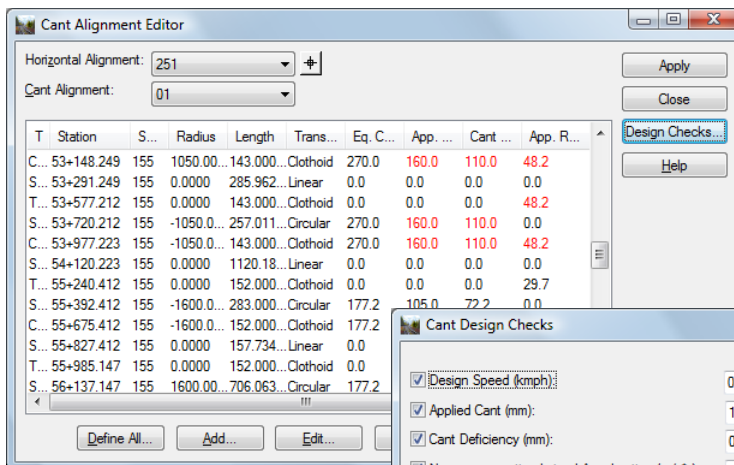
More Comprehensive Design Checks

- Includes
    - CEN Standards
    - Austrian Rail
    - Danish Rail
        - will be updated in *SELECTseries 3*
    - German Rail
    - Italian Rail
    - ProRail / Dutch Rail
    - Russian
    - Transrapid (maglev)

- Execute as you design or as a post-design process
    - *Interactive + passive*
    - *Ideal for checking a consultant's design*

- Written to match a railway's requirements

Roads and Bridges
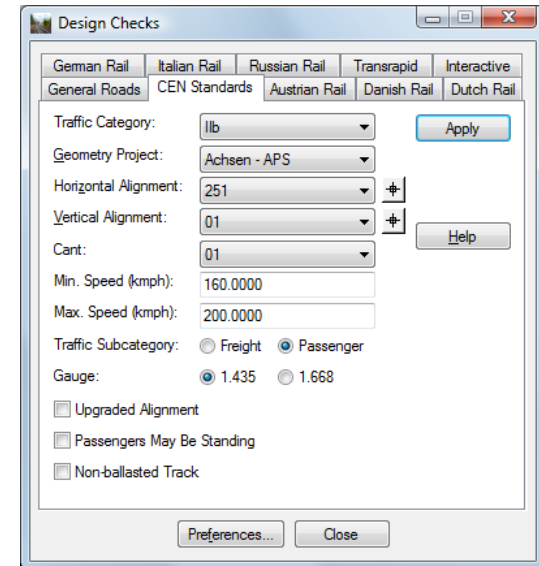
Design Checking

- ## Not just warnings!
  - ### Now it also indicates if the geometry is *acceptable!*
  - ### Good for QC
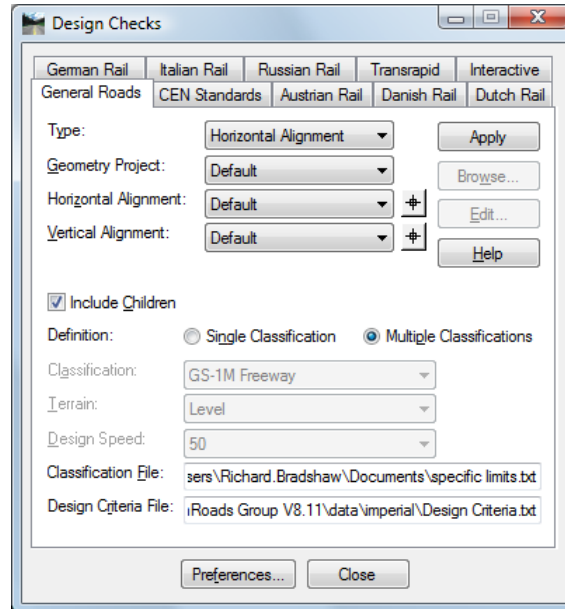

```
Checking stopping sight distances for alignment 'Default'

10+550.0000
Classification: GS-1M Freeway Terrain: Rolling Speed: 60
Warning: Desirable minimum stopping sight distance exceeded!
Desirable minimum stopping sight distance: 205.0000
Desirable minimum length should be: 499.1020
Actual length: 300.0000

11+050.0000
Classification: GS-1M Freeway Terrain: Rolling Speed: 60
Acceptable: Actual length is greater than desirable minimum stopping sight distance.
Desirable minimum stopping sight distance: 205.0000
Actual length: 300.0000
```

Roads and Bridges
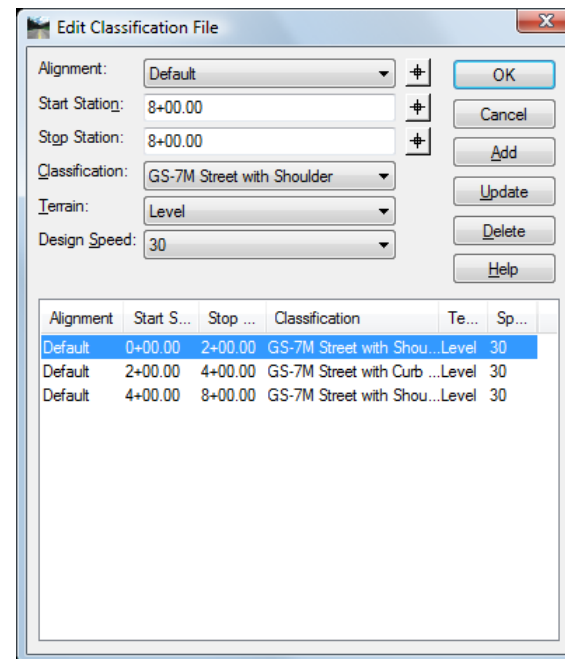
User Interface

User interface enhancements.

Roads and Bridges

User Interface Enhancements

- Smaller dialogs

- Moved buttons to right-click popup menus

- *And to avoid user panic, an Alert has been added!*
  - After getting this Alert for awhile, check the button in the lower left!
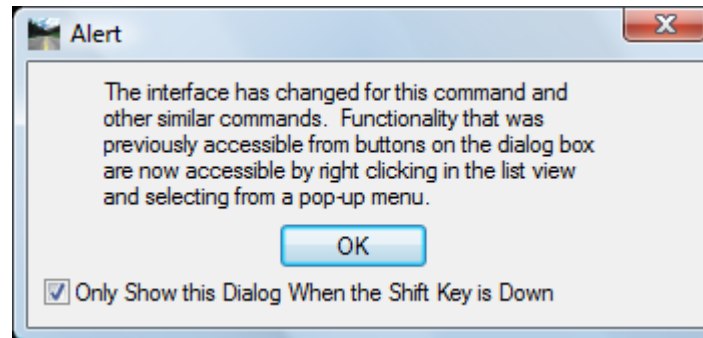
Configurable List View & Dialog Resizing

- ## Right click in title and select data of interest
  - *Check Integrity*
  - *Review / Edit Regression Points*
  - *Cant Alignment Editor*

Roads and Bridges

Less Clutter

- Moved buttons to *right click* context sensitive pop-up menus

- Eliminated tabbed dialogs
  - Everything is together in one dialog but still without excess clutter!

Tree / Leaf User Interface

- Converted most commands to tree / leaf
  - Allows greater consistency
  - Allows for potential enhancements
  - Allows for display / annotation during edits!

- You may / will need to look at preferences!
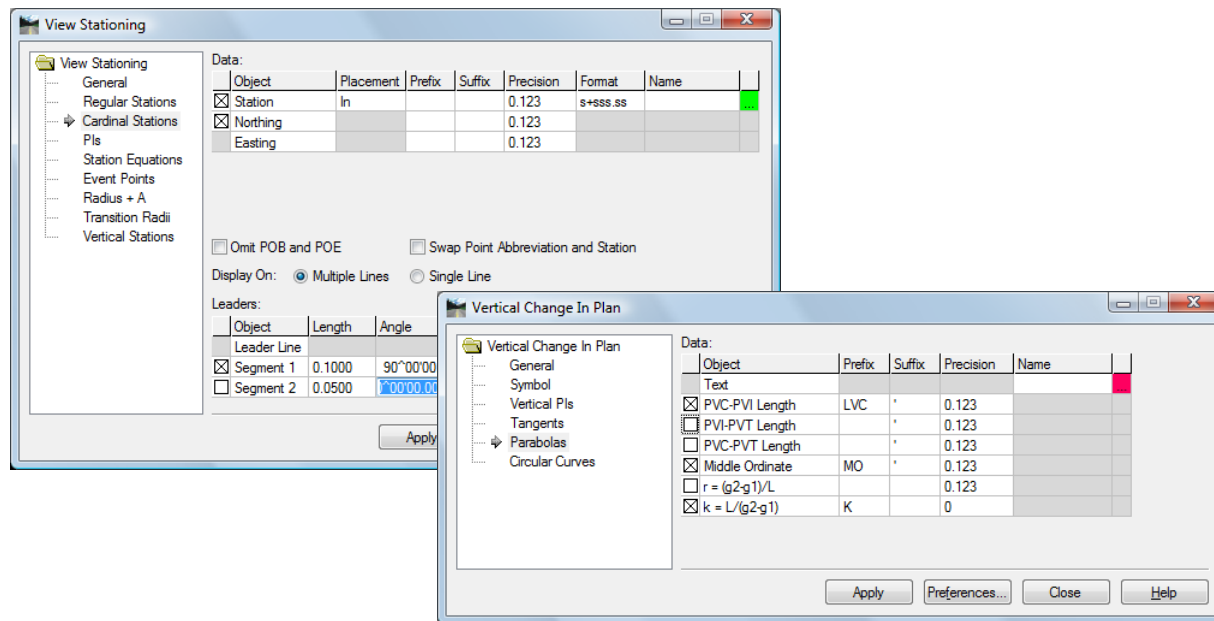
Just more examples…

- *View Horizontal & Vertical Regression Points*
  - Additional content
    - Other points of interest
    - Combined horizontal & vertical slews

Roads and Bridges

Just more examples…

Roads and Bridges

Just more examples…

Roads and Bridges

# Completing in SELECTseries 3

Swept Envelope Analysis

New functionality for the creation of vehicle swept envelopes

Bentley

Before Going Any Further, A Definition

- From the British Railways Track, Volume 9, Track Terminology book:
  - Swept Path – The plan area occupied by a rail vehicle as it moves along a track. The width of the swept path at any point is the same as the width of the swept envelope at that point.

  - **Swept Envelope – The kinematic envelope enlarged to allow for the effects of vertical and horizontal curvature, including end throw and centre throw of vehicles and cant applied to the track.**

  - Kinematic Envelope – The cross-sectional profile if a rail vehicle enlarged to include the effects of dynamic sway and vertical movement caused by speed, track curvature and cant, track position tolerances, rail wear, rail head/wheel flange clearances, tilt, vehicle wear and suspension performance at the particular location under consideration. Abbreviated to KE.

Bentley

Swept Envelope Analysis

- New functionality for the creation of swept path / vehicle envelopes
  - Results can be
    - Horizontal projection only
    - Interactive or
    - 3D mesh
  - Up to 3 vehicles in tandem
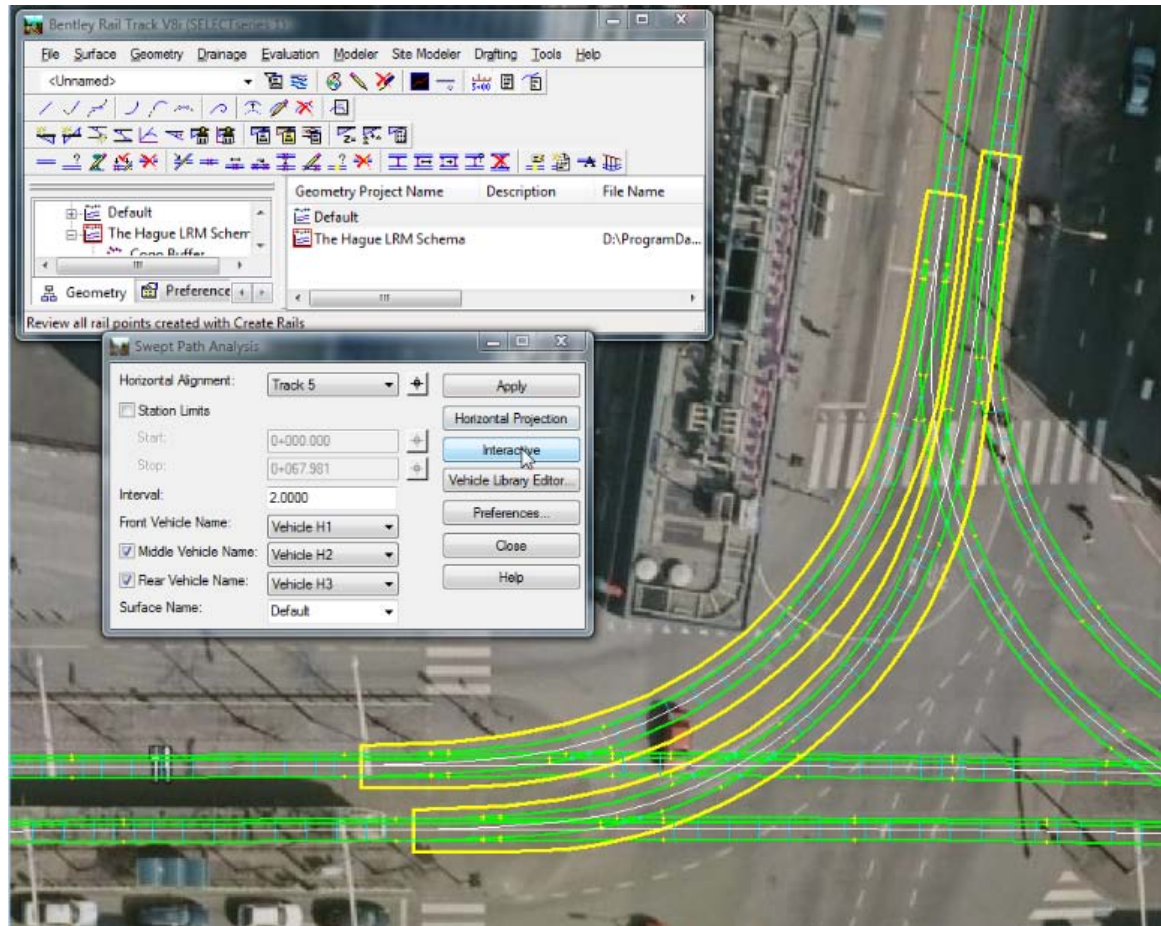 - Uses horizontal, vertical and cant geometries

Roads and Bridges
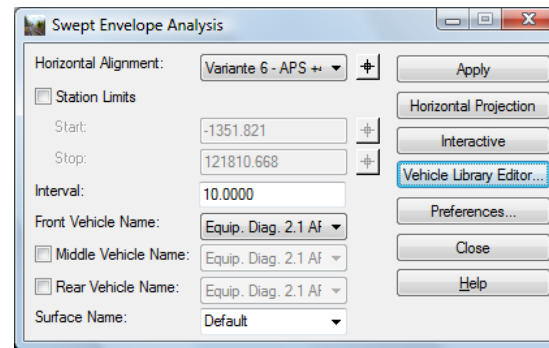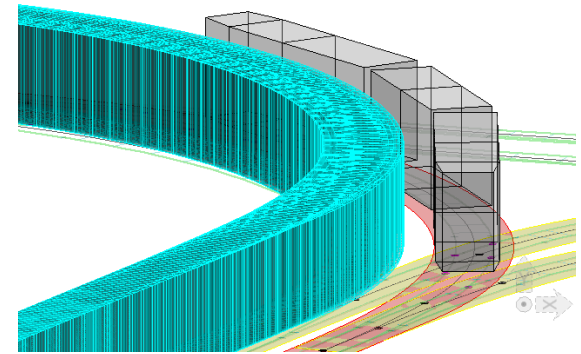
Vehicle Library

- ## Manages an XML based file of vehicles
  - ..\Bentley Rail Track V8.11\data\metric\swept envelope vehicles.xml

- ## A selective / interactive import from .dgn
  - Bogie points
 - Optional articulation points
  - Front, middle & rear sections

Roads and Bridges

Short AVI

Roads and Bridges
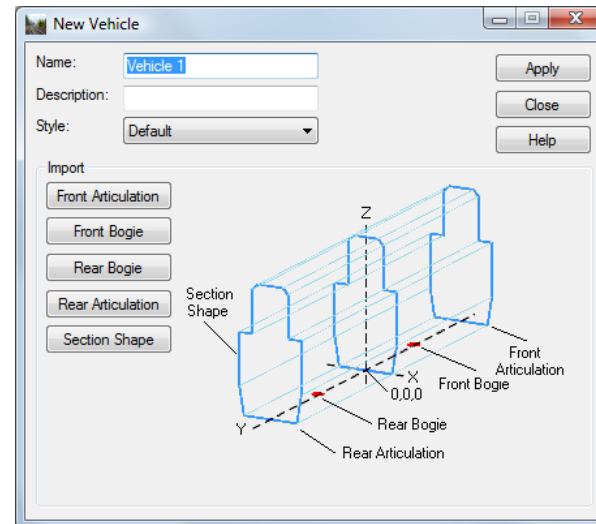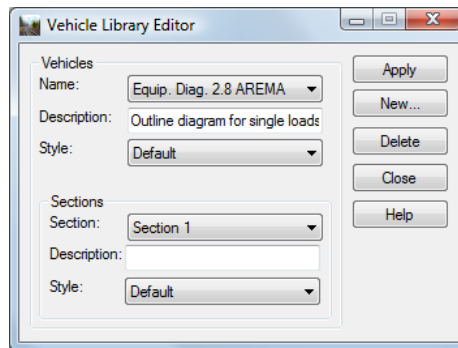
Network Solution

New functionality that allows the user to create alignments including turnouts that have simple relationships.

Bentley

Network Solution

- Primarily written for customers in The Netherlands, but it can adapt to others!

- Utilizes *existing solvers*
  - Multi-Element Connection
  - Turnout Connection

    Or

  - Components

Roads and Bridges
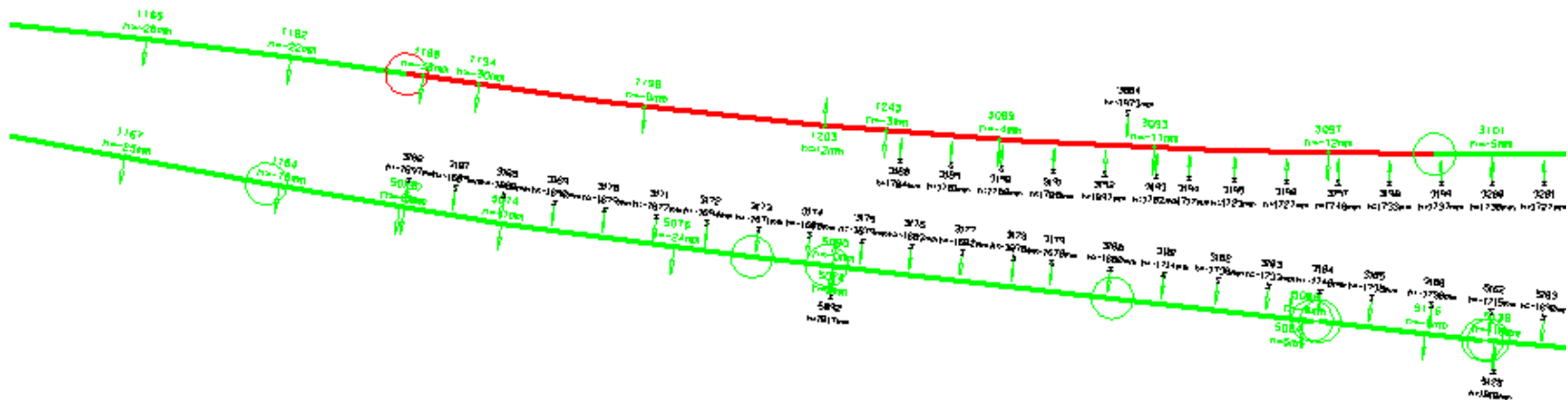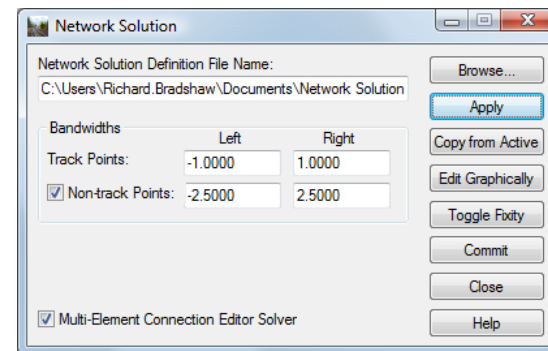
Network Solution & Turnouts

- Relating one cross-over to another cross-over
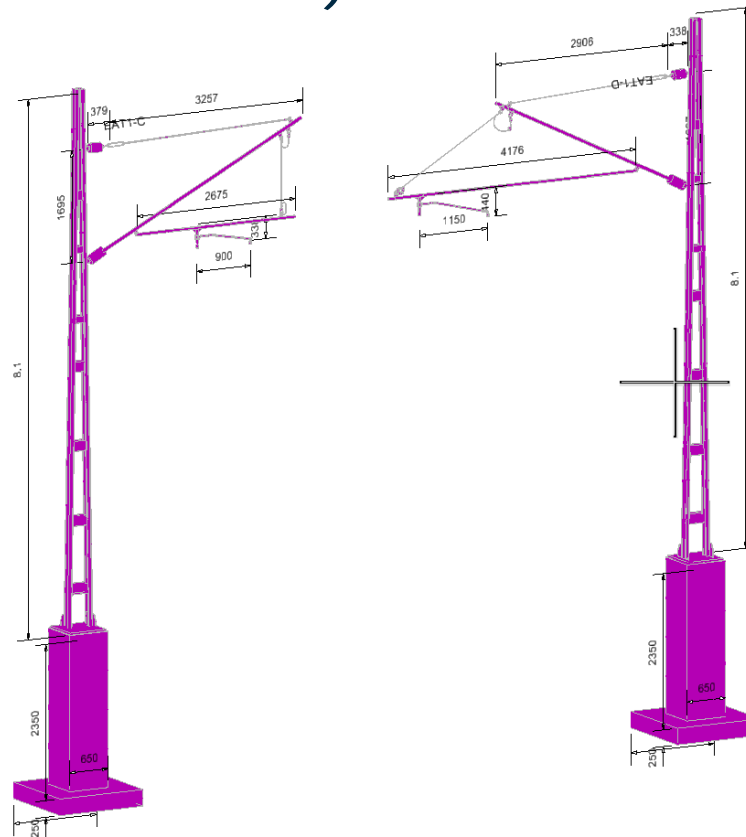
Roads and Bridges

Demo

- ..\Documents\Copenhagen\Network Solution\Test case 7.txt

- ..\Documents\Copenhagen\Network Solution\Test case 10 (Arcadis example w turnouts).txt

Power Rail Overhead Line

This will be a *new* product for the creation of overhead line equipment for electrified railways.
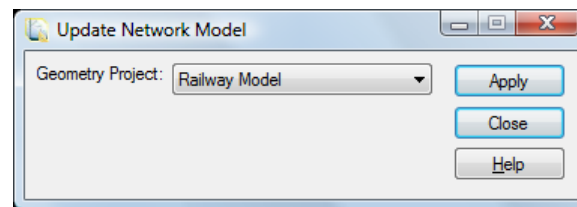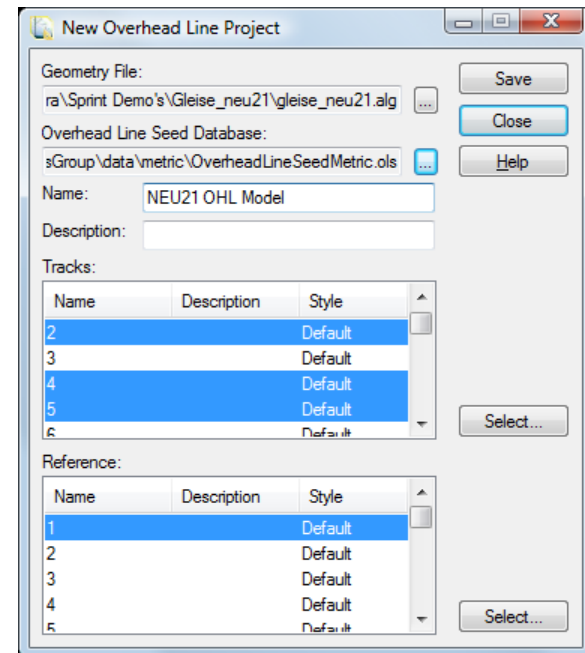
Roads and Bridges

Equipment

- Components (i.e. nuts and bolts)

- Assemblies (i.e. cantilevers)
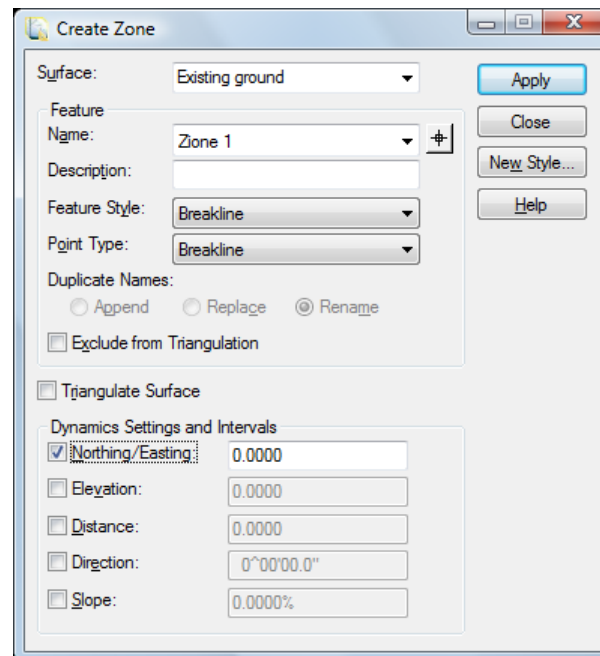 - 3D Cells

- Hierarchies

- Templates

Network Model

- A network model is created from **Bentley Rail Track** geometry
  - Horizontal
  - Vertical
  - Cant
  - Turnouts

- Update vertical & cant
 - And update the model!

Roads and Bridges

Zones

- A *zone* is an area where you can not place overhead line structures
  - A road crossing
  - A utility crossing
  - Other objects that you need to avoid

Surfaces

- A *surface* is an obstruction, like a bridge above the track, where a wire run may need to be lowered to provide clearance between the wire and the structure.

Roads and Bridges

Bentley
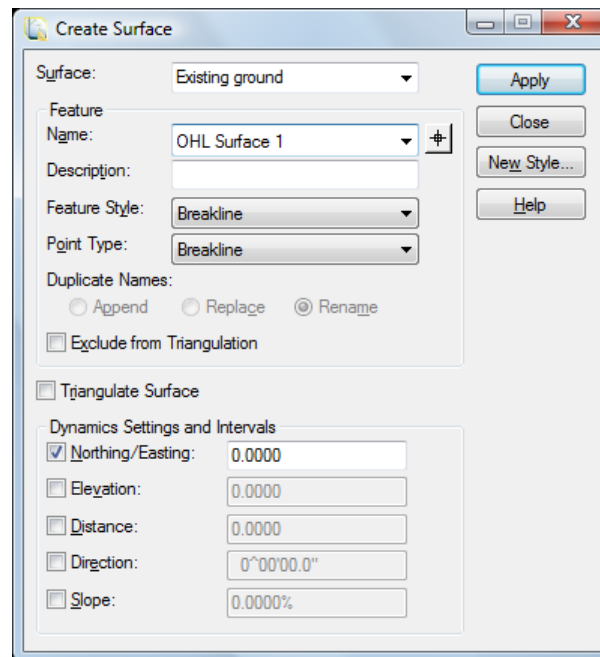
Overlaps & Reference Lines

- Overlaps are where wire runs go in and out of service, one wire ends and a new wire starts

- Reference lines are working lines upon which structures will be placed
  - Placement is based upon design rules for a specific catenary system
    - Look up tables
    - User defined algorithms
  - Placement may need to be adjusted to avoid obstructions
  - Placement is interactive

Reference Lines

Design Rules:	Sweden		Apply
Catenary System:	ST 7.1/7.1		Close
Track Overlap:	Tabell 7.8		Help

Control Tracks

| Rightmost: | Right Track | |
| Leftmost: | Left Track | |

☑ Compute Plain Line Spacing

Table	Radius	B1	B2	b1	b3	b4	b5			
Tabell 7.7	INF	-0.3	0.3	-0.3	-0.1	0.1	0.3			
Tabell 7.7	20000	-0.3	0.3	-0.3	-0.1	0.1	0.3			
Tabell 7.7	10000	-0.3	0.3	-0.3	-0.2	0.1	0.2			
Tabell 7.7	9000	-0.3	0.3	-0.3	-0.2	0.1	0.2			
Tabell 7.7	8000	-0.3	0.3	-0.3	-0.2	0.1	0.2	60	53	60

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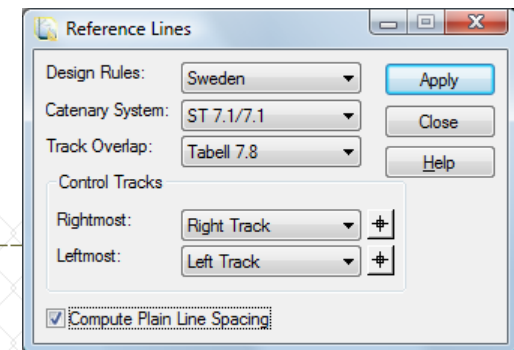
Turnout Reference Lines

- ## Place reference lines relative to a turnout
  - Uses look tables related to the turnout's style
  - User define lengths
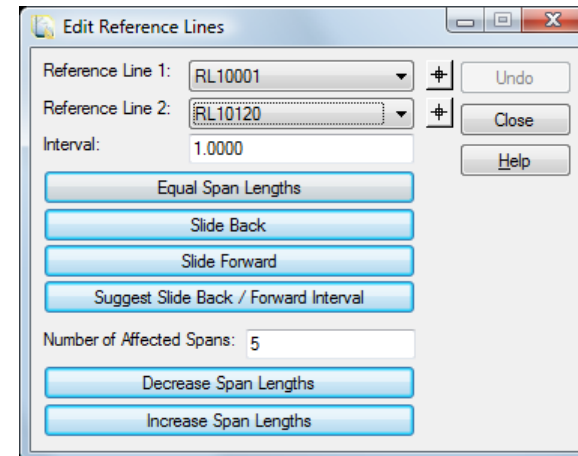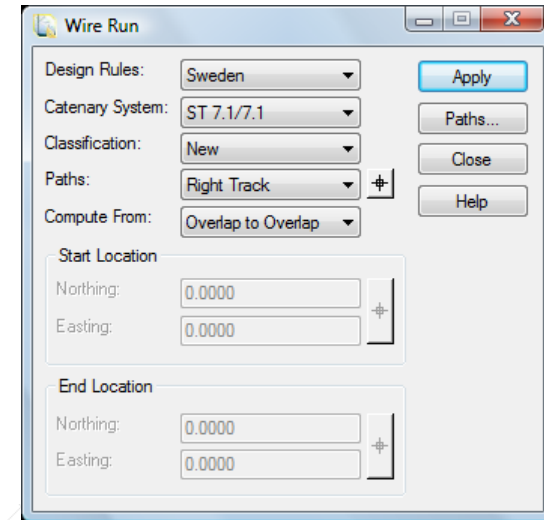
Reference Line Editing

- ## Adjustment of reference lines
  - Normally by small amounts
  - Adjusting span lengths
  - Updates entire model
    - Reference lines
    - Overlaps
    - Wire Runs
    - Span Bonding
    - Structures
    - Other wires
      - And all annotation

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Wire Runs

- ## Wire runs consist of
  - Contact wire
  - Carrier wire
  - Droppers

- ## Utilizes design rules

Design Rule Set: Sweden
Version: 1.1

Name	Maximum Span Length	Maximum Wire Run Length	Maximum Span Difference	Nominal Encumbrance	Minimum Mid Span Encumbrance	Minimum Wire Height	Maximum Speed	Nominal Wire Height	Maximum Wire Height	Minimum Span Length	Mid Span Contact Wire Sag	Maximum Dropper Spacing	Distance To First Dropper	Number Of Droppers	Catenary Wire Sag Start Position
S 4.9/5.9	60	1300	10	1.3	0.6	5.2	120	5.5	5.65	0	0.080	8	8	Odd/Even	At Cantilever
ST 7.1/7.1	60	1300	10	1.3	0.6	5.2	140	5.5	5.65	0	0.040	10		Odd/Even	At first dropper except in curves
ST 9.8/9.8	60	1300	10	1.3	0.6	5.2	180	5.5	5.65	0	0.030	10		Odd/Even	At first dropper except in curves
ST 9.8/11.8	60	1300	10	1.3	0.6	5.2	200	5.5	5.65	0	0.030	10		Odd/Even	At first dropper except in curves
ST 15.0/15.0	65	1600	10	1.55	0.6	5.2	250	5.5	5.65	0	0.030	7	6	Odd	At first dropper
SYT 15.0/15.0	65	1200	10	1.8	0.6	5.2	250	5.5	5.65	0	0	10	5	Odd	At first dropper

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Height & Stagger

- *Height* will adjust the vertical position of the wires

- *Stagger* will adjust the horizontal position of wires
  - Wires going in and out of service
  - Design checking
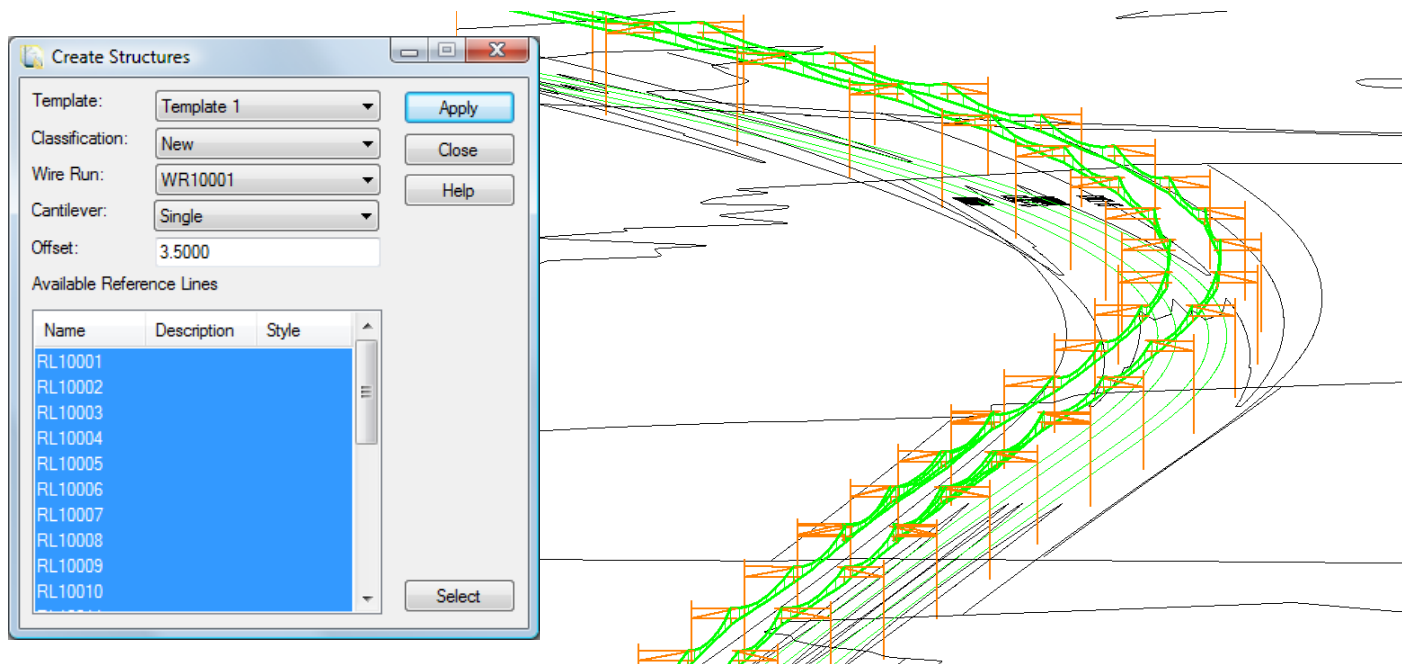
Wire Gradient

- Used to transition the wire height from the normal height to a height exception, say transitioning under a bridge

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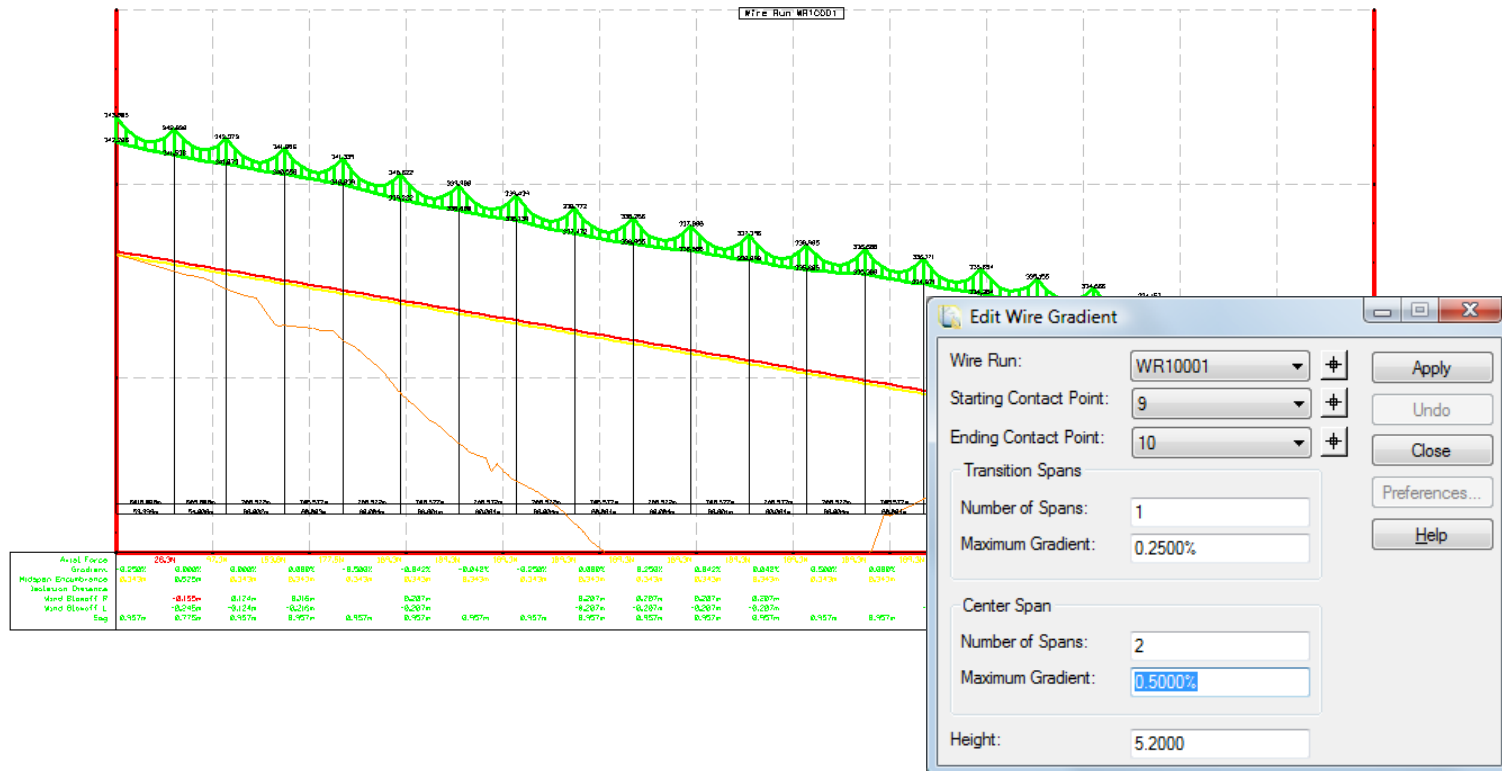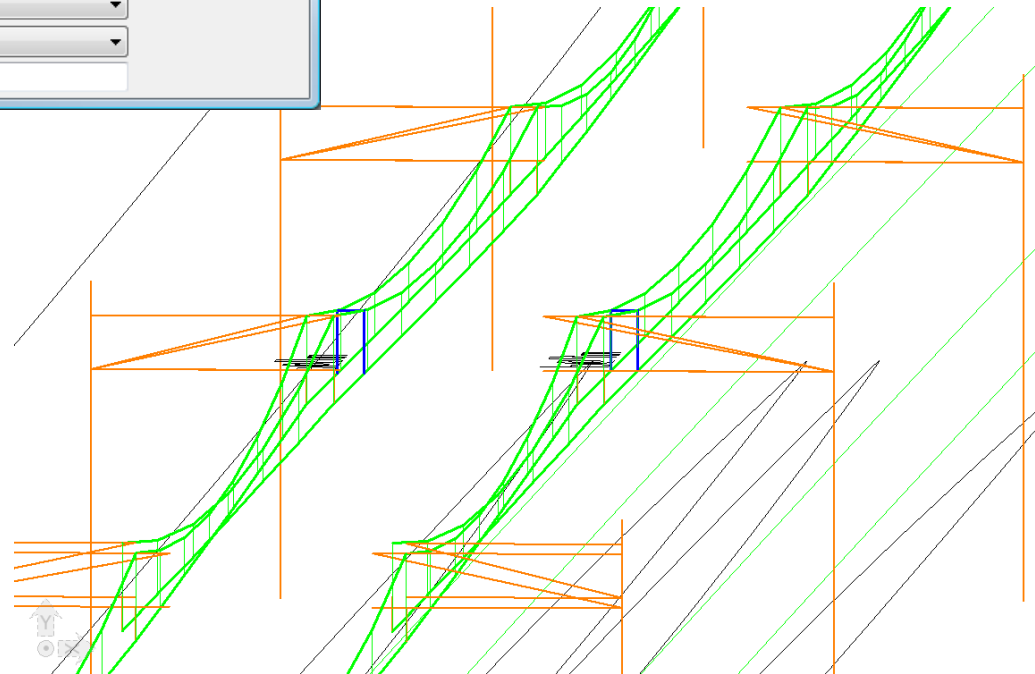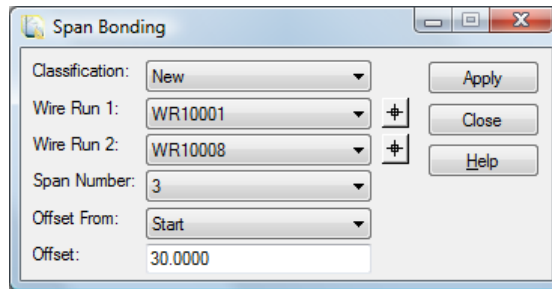
Structures

- ## Utilizes equipment defined in a data base
  - ### Components (i.e. Nuts, bolts, brackets…)
  - ### Assemblies (i.e. 3d cells of poles, cantilevers, etc.)
  - ### Templates
    - #### Combination of components and assemblies

Span Bonding

- Creates span bonding between adjacent wires

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Naming Utility

- Naming of
  - Reference Lines
  - Wire Runs
  - Span Bondings
  - Other Wires
  - Structures
    - Lots of customer variation

Plan Viewing

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Profile Viewing

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Example of View Profile Annotation
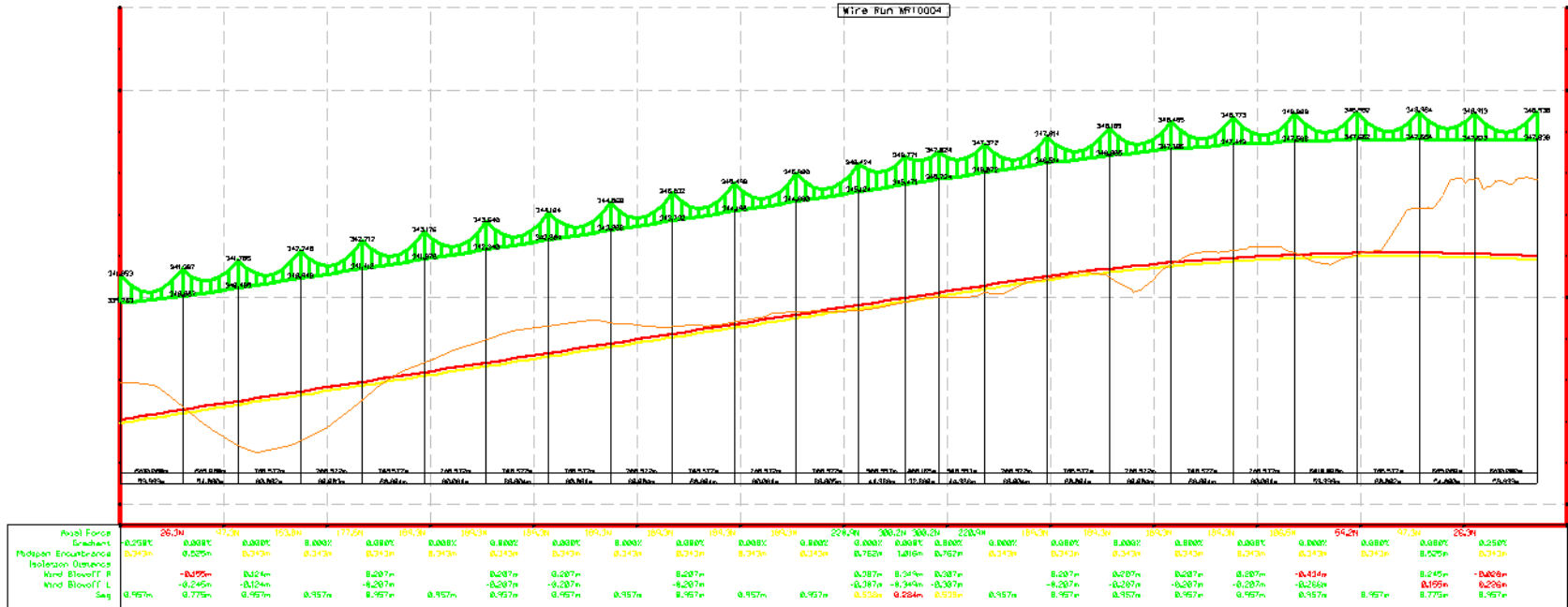
Axial Force		26.3N	97.3N	153.8N	177.5N
Gradient	-0.250%	0.000%	0.000%	0.000%	0.000%
Midspan Encumbrance	0.343m	0.525m	0.343m	0.343m	0.343m
Isolation Distance					
Wind Blowoff R		-0.155m	0.124m		0.207m
Wind Blowoff L		-0.245m	-0.124m		-0.207m
Sag	0.957m	0.775m	0.957m	0.957m	0.957m

Cross Sections

- Graphical data and

- Non-graphic data
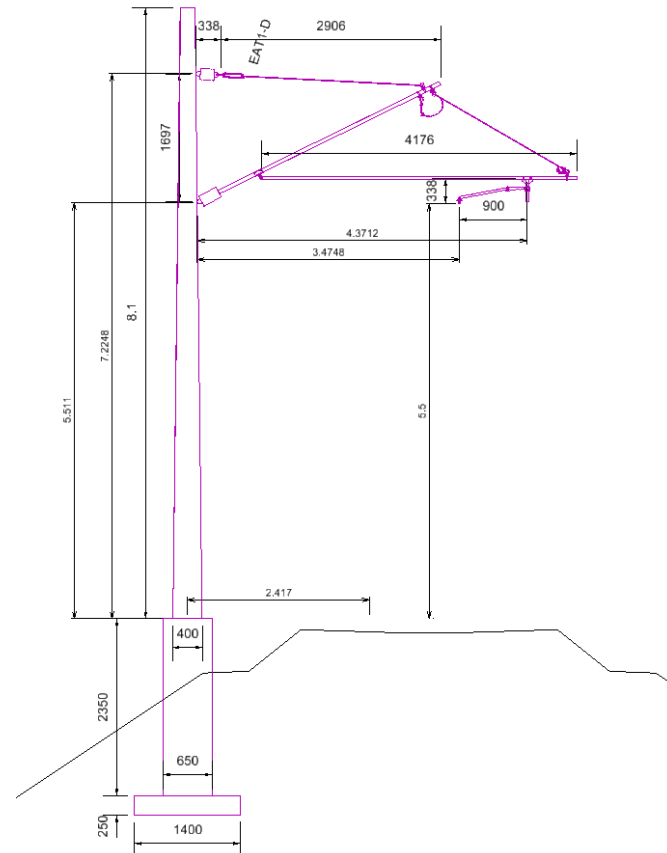
Assembly	Description	Count	Structure	Single Track Post 5	Component	Description	Count
EAT1-D		1	Chainage	7+026.571	1600-104	EAT1-D cantilever assembly	1
steady arm 0.9m - push		1	Orientation	N 17°33'27.78" E	1501-003	concrete footing, pole	1
foundation - pole		1					
Pole 8m		1	Wire	NW			
			Height	5.50			
			Stagger	0.40			
			Encumbrance	1.30			

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Reporting

- As always XML / XSL based

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Demo…

- ..\Documents\Vectura\Sprint Demo's\7.1k

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Continuing to *Enhance* and *Create* Global Rail Solutions!

Questions?

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