Bentley Rail Design Update

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Bentley
Sustaining Infrastructure

The Global Rail Market …

- is now worth € 125 billion / year
  - 59% Rolling stock
  - 30% Infrastructure
  - 11% Systems technology

Regional distribution of the global railway technology market.

Regional Trends

Regional trends

Western Europe: the high relevance of rail transport and continuing deregulation are the most important market drivers. In addition, there are important new projects in high-speed and urban rail transport.

Eastern Europe: this region has become much more important, due mainly to the rising importance of deregulation and improved financial conditions thanks to many countries' accession to the European Union. In addition, there are large installed bases of old vehicles and infrastructure which will have to be renewed.

North America: this market is shaped by freight transport, which has benefited substantially from economic growth in recent years. In the future, the focus will be more on urban transport. Extensive infrastructure and procurement projects are planned here.

South America: this market has also benefited in the past few years from the rising demand for raw materials. However, it must be assumed that current growth rates will not continue. A change of thinking is taking place in the market for urban rail transport. Urgently-needed infrastructure upgrades and the associated vehicle procurements are expected in the coming years.

Asia: the massive expansion and upgrading projects in China are shaping the market. India has very high growth potential and political announcements have been made to this effect. The high population in many cities and the lack of suitable commuter transport systems make billion-euro investments inevitable. Further investments are also being made in freight transport.

Africa/Middle East: investments are currently being made in urban rail transport. The somewhat ambitious new projects in high-speed rail and urban transport are predominantly limited to northern Africa, the Gulf States and South Africa. Continuing urbanisation in this region will lead to further growth in the long term.

CIS: the signs are pointing towards growth. The high importance of the railways, large stocks of old vehicles and infrastructure and a reinvigorated railway industry are resulting in high rates of growth. In Russia - the leading market - plans look fairly secure. The current focus is on the procurement of efficient rolling stock and renovation of the existing network.

Australia/Pacific: momentum is expected from the freight and urban transport sectors. Alongside Australia, New Zealand is also seeing a rise in investments following the recent renationalisation of the railway.

- Source: http://www.railjournal.com/

Bentley's Rail Design Solution Offers…

- Horizontal alignment design
- Vertical alignment design
  - Single and multi-element regression analysis for maintence
  - New line design
- Cant / superelevation design
- Turnouts
- Also includes *specialized* toolsets for
  - Design checking
  - Design to field
  - Light rail manufacturing
  - Magnetic levitation

Adapts to Any Project or Workflow

- 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
  - Available in German, Spanish, Chinese plus other languages
- Bentley Rail Track is localizable
  - Deliver standard turnouts
  - Build in railway specific design checking

Major Differences Between Road & Rail

- *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

Horizontal & vertical geometry

Includes new design as well as maintenance workflows.

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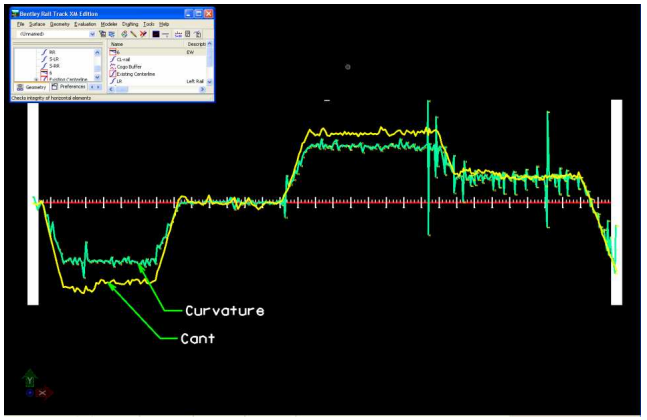
Alignment Design

- 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 – **(New in V8i)**
  - 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

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 – **(New in V8i)**
- Slew diagrams and reporting

Vertical Alignment Healing

- An attempt to synchronize / update the vertical alignment when the horizontal alignment has changed.
  - The coordinate position of vertical PI's will be held!
    - Stationing up-station of the edit will change, but the coordinate position remains!
    - Add a station equation to account for the gap or overlap (and stationing will return to "even" values!)
    - **(New in V8i)**

Additional Transition Spirals

- Cubic parabola
  - Length along axis (Australia)
  - Length along tangent (Czech & NSW **(New in V8i)**
- AREMA - **(New in V8i)**
  - Chord definition
  - Length along axis
  - Simple & compound

```
Element: AREMA
                TS (         )          3+37.1050    10191.4712    10277.4501
               SPI (         )          5+37.0953    10305.0631    10442.0496
                SC (         )          6+37.1050    10357.5103    10527.2682
  Entrance Radius:                          0.0000
      Exit Radius:                       2864.9344
           Length:                        300.0000
            Angle:                    3^00'00.0" Right
         Constant:                        927.0816
     Long Tangent:                        199.9902
    Short Tangent:                        100.0646
       Long Chord:                        299.9634
               Xs:                        299.9177
               Ys:                          5.2370
                P:                          1.3107
                K:                        149.9786
 Tangent Direction:    N 55^23'24.1" E
  Radial Direction:    S 34^36'35.9" E
   Chord Direction:    N 56^23'25.4" E
  Radial Direction:    S 31^36'35.9" E
 Tangent Direction:    N 58^23'24.1" E

Element: Circular
                SC (         )          6+37.1050    10357.5103    10527.2682
                PI (         )         10+99.8233    10600.0368    10921.3357
                CC (         )                        7917.6297    12028.8778
                CS (         )         15+54.5718    10706.1755    11371.7164
            Radius:                       2864.9344
 Design Speed(mph):                         70.0000
     Cant(inches):                                5
             Delta:                  18^20'57.6" Right
Degree of Curvature(Chord):              2^00'00.0"
            Length:                        917.5133
 Length(Chorded):                          917.4667
           Tangent:                        462.7183
             Chord:                        913.5973
    Middle Ordinate:                        36.6515
          External:                         37.1265
 Tangent Direction:    N 58^23'24.1" E
  Radial Direction:    S 31^36'35.9" E
   Chord Direction:    N 67^33'52.9" E
  Radial Direction:    S 13^15'38.3" E
 Tangent Direction:    N 76^44'21.7" E
```

Turnouts

Specialized geometric objects

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Turnouts

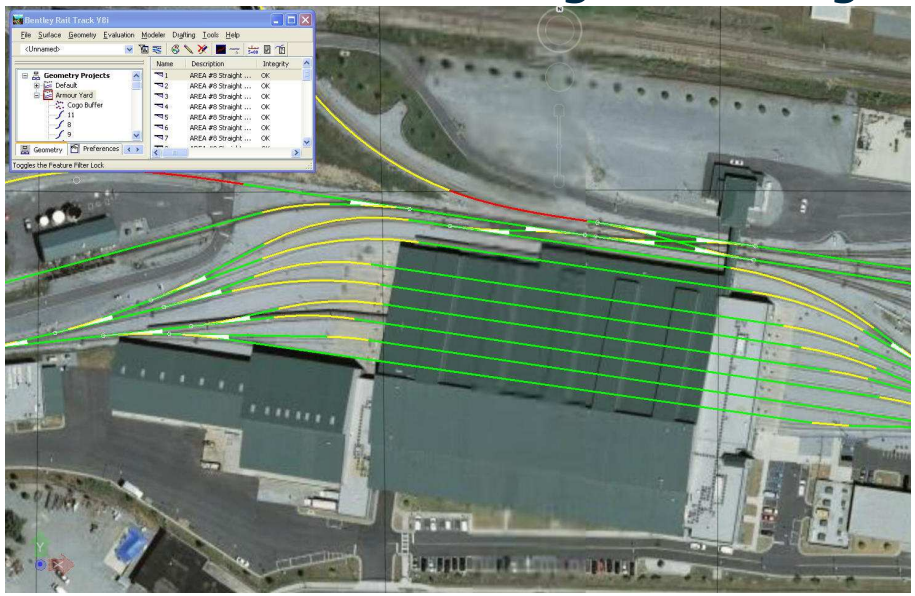
- Single, double and slips
  - Tangential and non-tangential turnouts
- Multiple bending / flexing methods to satisfy various industry standards!
  - Swiss
  - Germany / Austrian
  - UK

Turnout Library

- Typical Turnout Library Editor
  - Creation of typical turnouts (standards)
    - The software delivers various country standards
      - German (heavy & light rail)
      - UK (113A's & RT60's)
      - Indian Railways
      - Dutch Railways / ProRail
      - Spanish
      - Or we will help you to create them
- AREMA Alternative (US + Canada)
  - Familiar terminology
    - Matches AREMA Track Manuals
    - Delivered with the product

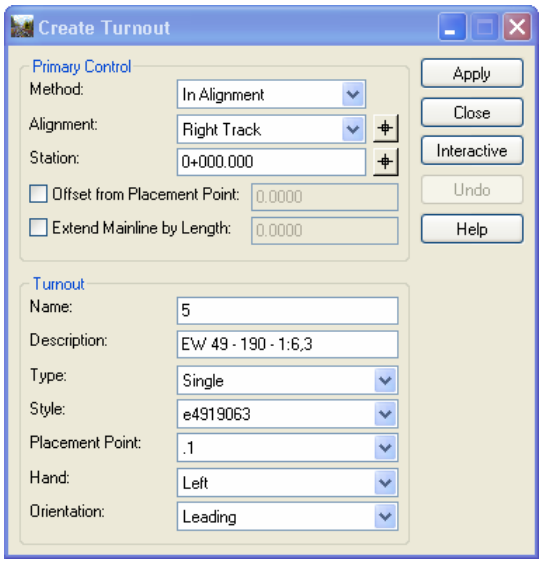
Advantages of utilizing turnouts

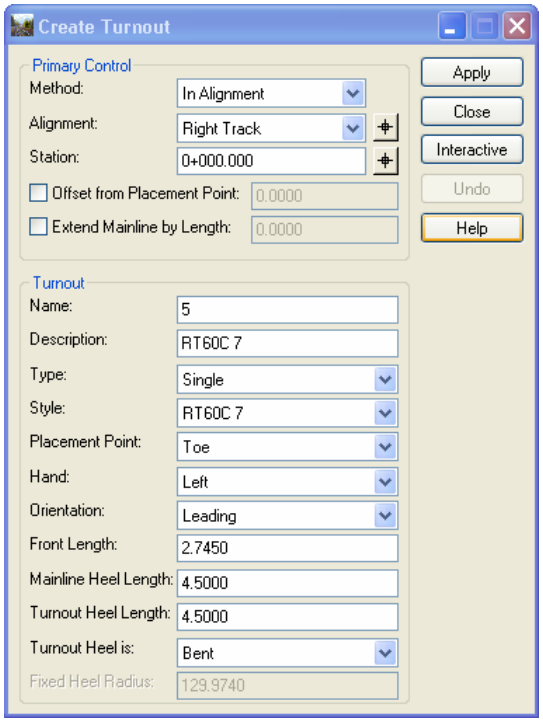
- Manage the underlying horizontal alignments
  - Once created the software will re-establish the associated turnouts
  - After editing the software updates the associated turnouts and horizontal alignments
  - Maintain the rules for bending turnout geometry

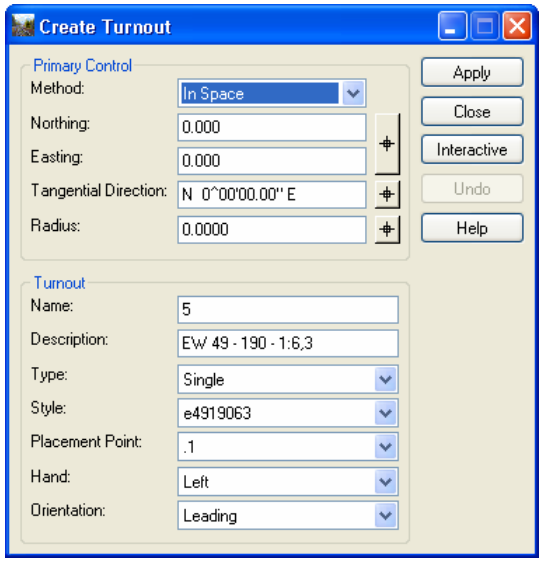


Creating Turnouts

- Consolidate and minimized functionality **(New in V8i)**
  - Interface changes based upon library
  - Create *from the interface* or *interactively*

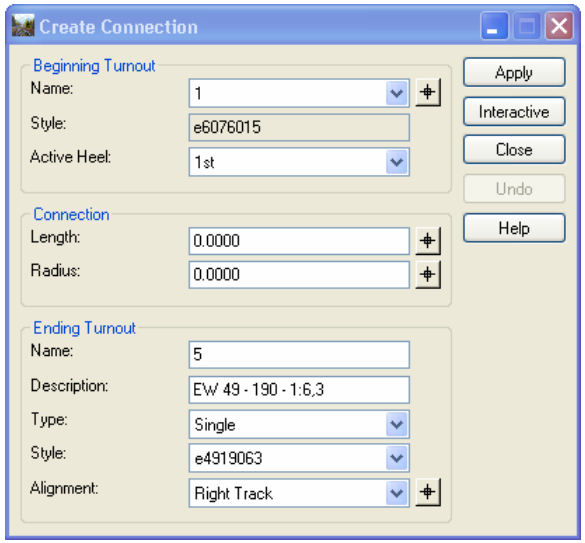






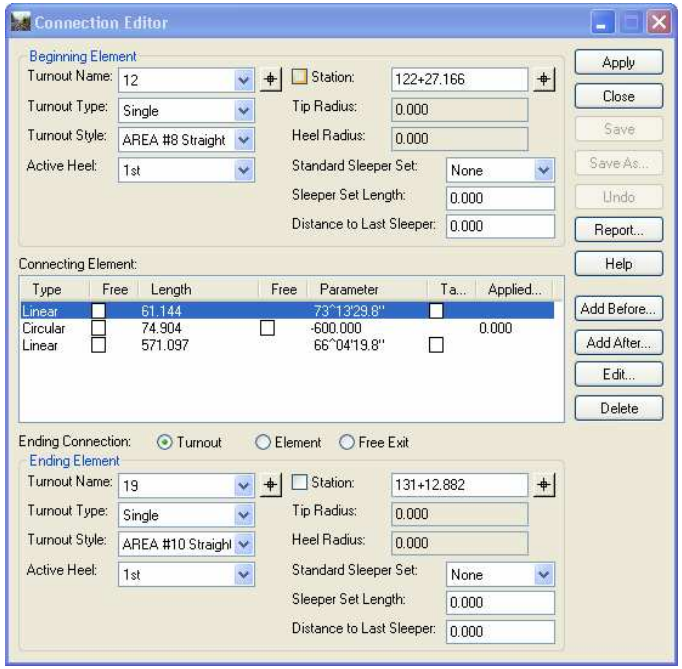
Create Turnout Connections

- Start with a single turnout and create a connection to a new turnout **(New in V8i)**
  - A simplification to minimize using the *Turnout Connection Editor* for simple crossovers
  - Ending turnout will match the beginning turnout.
  - Connection is linear or circular

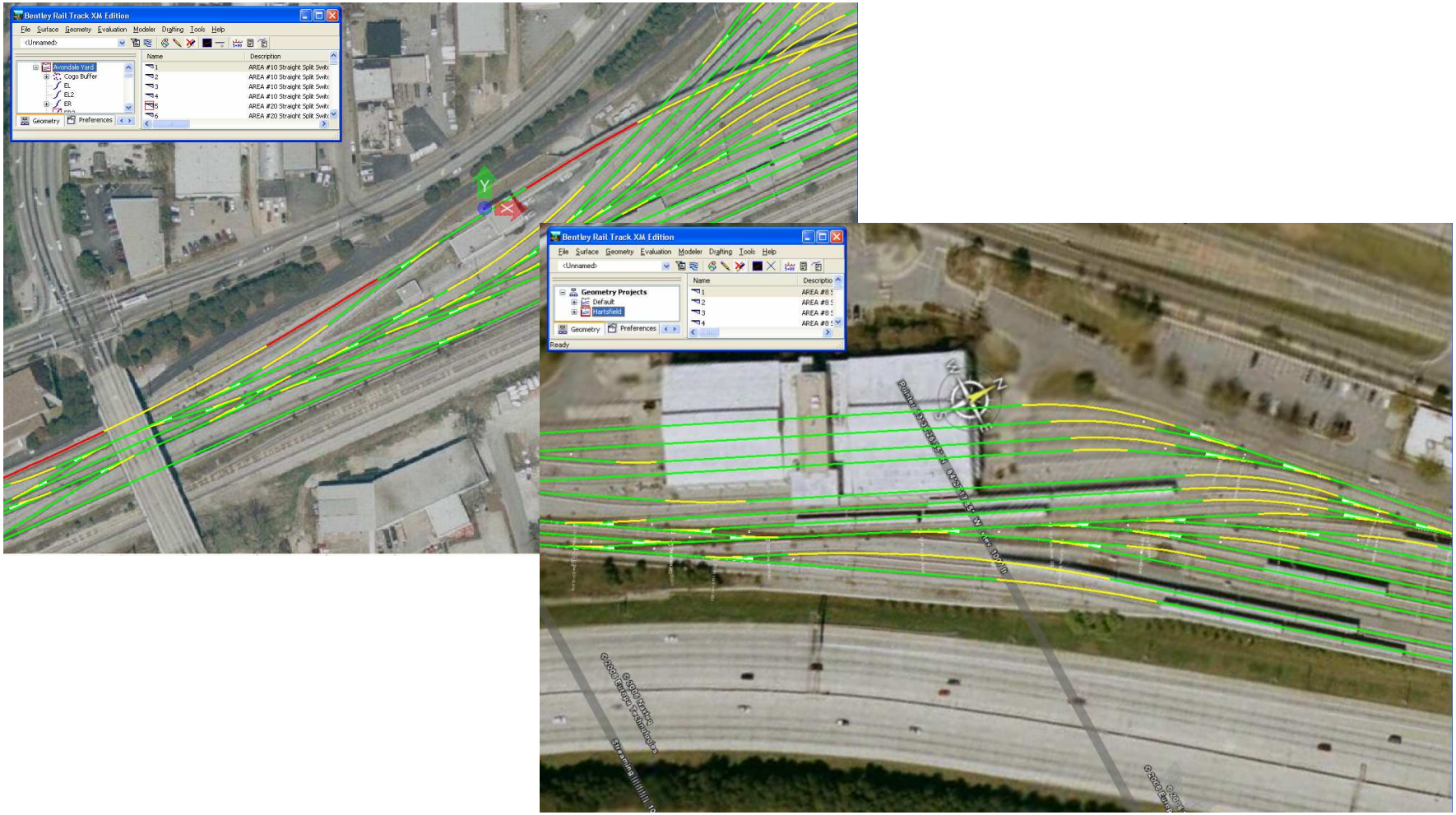


Turnout Connection Editor

- Used for more advanced geometric constructions
  - Crossovers
  - Sidings
- Editing an existing construction
- Maintains *rules* and *relationships*!



Resulting in models like these yards!



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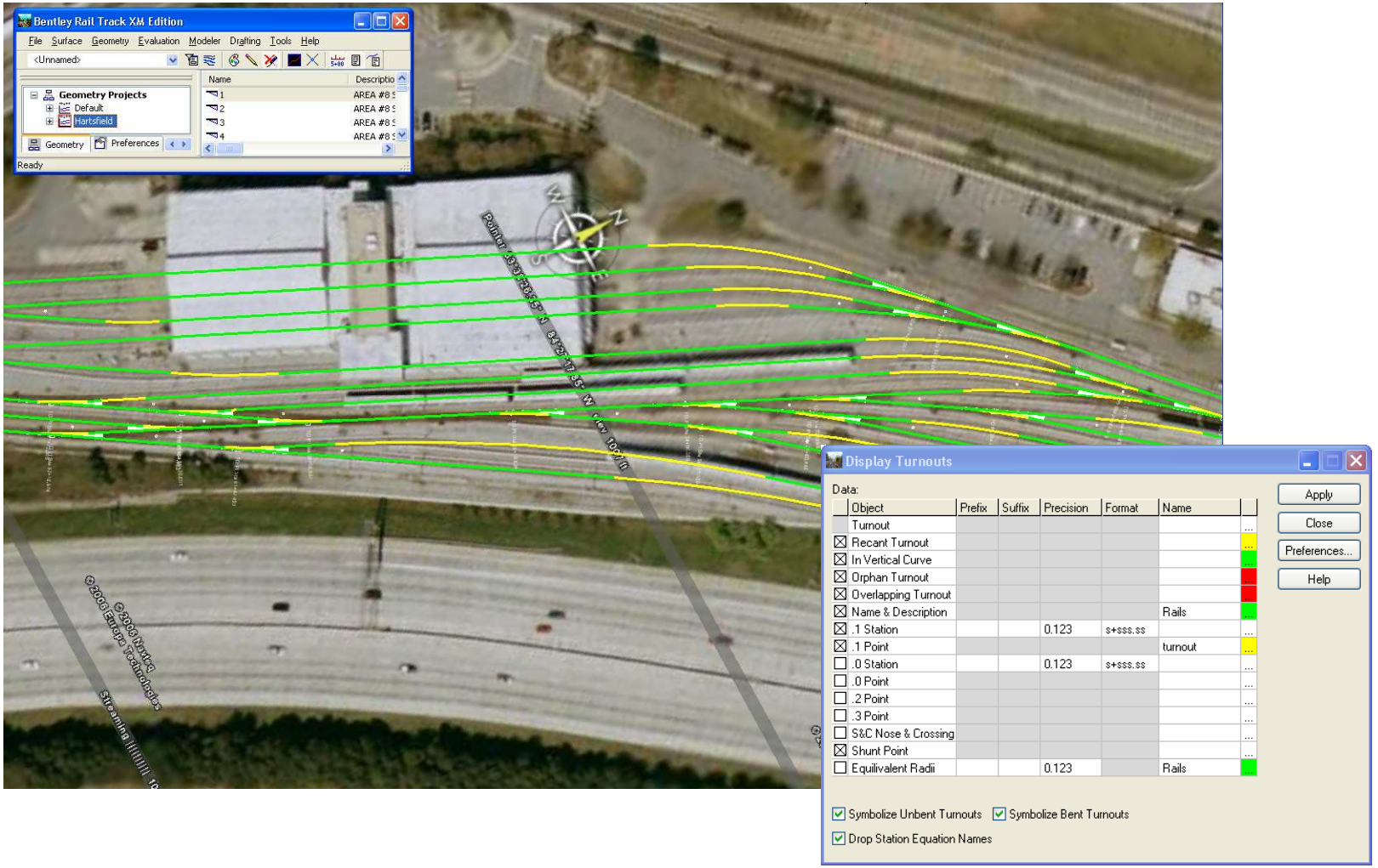
Detailed Design Checking

- Includes
  - CEN Standards
  - Austrian Rail
  - Danish Rail
  - Dutch Rail
  - German Rail
  - Transrapid
- 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

Display and also design check



Working with Leading Suppliers

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

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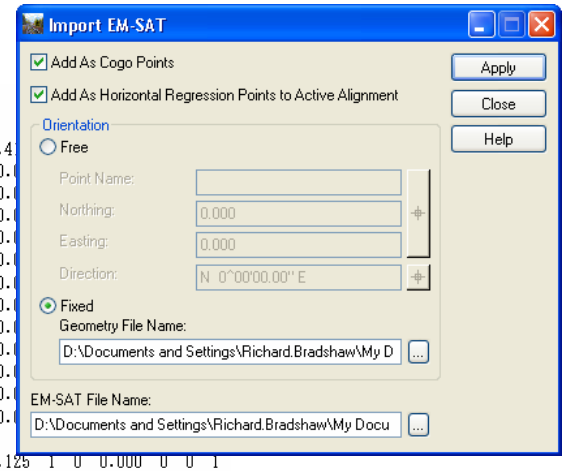
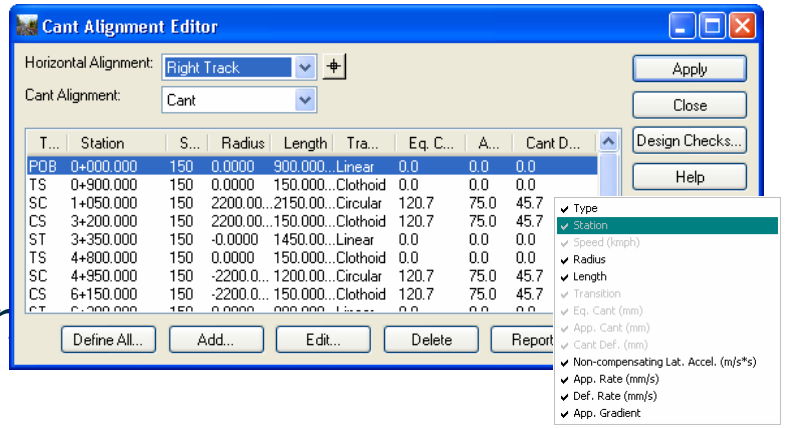


Usability

- Configurable list views
  - Right click in list view title and check on / off columns
- Resizing dialogs
  - *Cant Alignment Editor*
  - *Check Integrity*
  - *Review / Edit Regression Poir*
  - *Others…*



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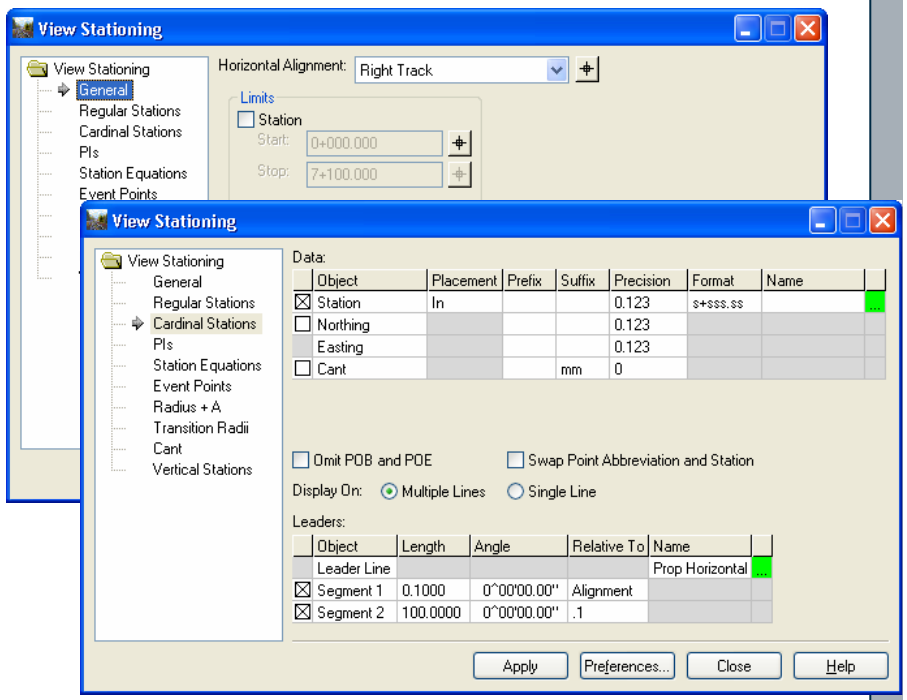
Updated GUI Presentation

- Implement *tree view* and *grids* for various geometry view commands
  - *View Stationing*
  - *View Station &Offset*
  - *View Curve Set*
  - *View Vertical in Plan*
  - *View Switch Height Plan*
  - *Others…*
- Consistency



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New in V8i (General)

- Roundabouts was added to the InRoads Group install. Activate the roundabout functionality by clicking a command such as the Civil Library Browser under MicroStation > Tasks > Civil > Roundabouts.
- Civil AccuDraw is new functionality similar to MicroStation AccuDraw with added civil engineering functionality. Access Civil AccuDraw through the MicroStation Tools menu.
- Civil Global Positioning System adds civil engineering functionality to the MicroStation > Tools > Geographic > Global Positioning System (GPS) command.

New in V8i (General)

- Horizontal Element > Edit Horizontal Element. The Maintain Element Connectivity with Minimum Movement allows the user to change the geometry a line or a circular arc and have the adjacent elements also update. The option utilizes the component technique of fix, float and free to re-compute the geometry.

- Regression > Edit/Review Regression Points. The Select button is now called Select Only. This button will only select points for regression. The user can still do <Ctrl> + Select to include points in the analysis. The user can still <Shift> + Select to include points in a fence in the analysis. Also, the Regress button is now called Select & Regress. This button will allow the user to select the regression points and automatically perform the regression. The software will stay in this heads-up mode to select and regress multiple elements, until the user rejects. These changes apply to both the Edit / Review Horizontal Regression and Edit / Review Vertical Regression commands.

New in V8i (General)

- Regression > Edit/Review Regression Points. The columns are now configurable.
- Regression > View Regression Points and Evaluation > Profile > Annotate Profile > Horizontal and Vertical Slew leafs. The ability to display the slew values in millimeters was added.
- Regression points are now removed from the buffer when the corresponding cogo point is deleted.

New in V8i

- Translators > Import EM-SAT was added to import data from a Plasser & Theurer survey machine.
- View Geometry > Stationing. The ability to display cant annotation at a user defined interval was added.
- Superelevation > Cant Editor. The columns are now configurable.

New in V8i

- Geometric element freedoms are now maintained with the data for the life of the data. The following commands are affected:

Geometry > Horizontal Regression > Multiple Horizontal Element Regression Analysis

Geometry > Vertical Regression > Multiple Vertical Element Regression Analysis

Geometry > Turnouts > Turnout Connection Editor

Geometry > Turnouts > Create Connection

New in V8i

- Horizontal Regression > Multiple Horizontal Element Regression Analysis. Editable Applied Cant fields were added for the Beginning and Ending Elements and an Applied Cant column was added in the Connecting Element list.
- Horizontal Regression > Multiple Horizontal Element Regression Analysis. If the Beginning Element is the first element in an alignment then the user will be able to edit a linears tangential direction or a circular arcs radius. In a similar manner, if the Ending Element is the last element in an alignment then the user will be able to edit a linears tangential direction or a circular arcs radius.
- Horizontal Regression > Edit/Review Horizontal Regression Points. Quick Regression was added.

New in V81

- Transition spirals. The cubic parabola spiral implementation has been enhanced for Czech Railways. The primary difference is the Czech cubic parabola is defined by the length along the spirals tangent rather than the length along the centerline.
- Transition spirals. The cubic parabola spiral implementation has been enhanced for New South Wales, Australia.
- Transition spirals. The software has been enhanced to also include the America Railway Engineering and Maintenance Associations cubic spiral. The AREMA transition is based upon degree of curvature defined as chord definition.
- Turnouts. Combined turnouts and the Switch & Crossing (S&C) style of turnouts into a single set of functionality. Within the Create Turnouts and Create Connection commands, the classical style of turnouts now has all of the applicable options that S&C has.

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New in V8i

- Turnouts. The software now attempts to re-establish orphaned turnouts.
- Turnouts > Display Turnouts. The ability to display the station at the beginning of a turnout was added.
- Turnouts > Display Turnouts and Display Turnouts in Profile have been converted to grid views.
- Turnouts > Create Connection was added.
- Create Vertical through Turnouts. The computations were simplified to always copy & transform elements to the non-controlling vertical.
- Drafting > Network Rail Extensions was added to display turnouts using Network Rail methodology.
- Light Rail Manufacturing > Annotate Rail Offsets has been enhanced.
- Utilities > Design Checks > Dutch Rail tab was added.

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Bentley Rail Overhead Line

A *new* product for the creation of overhead line equipment for electrified railways

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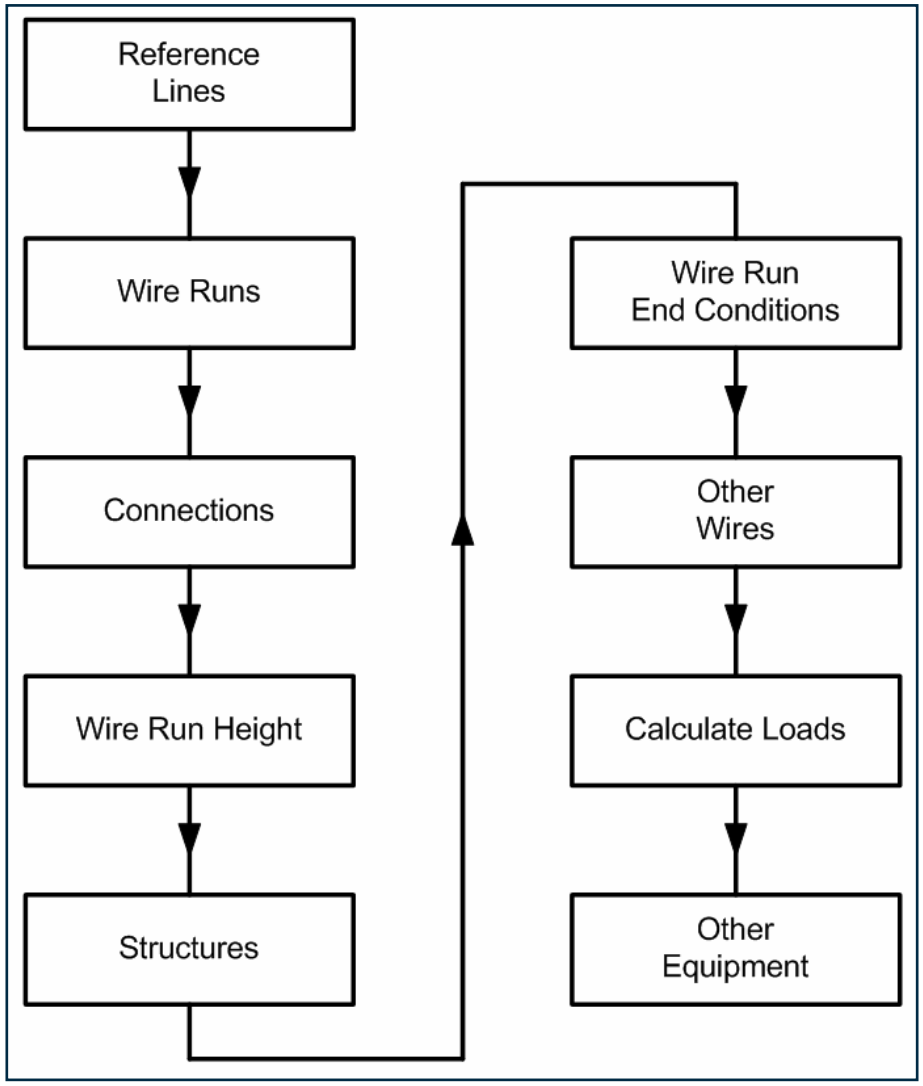
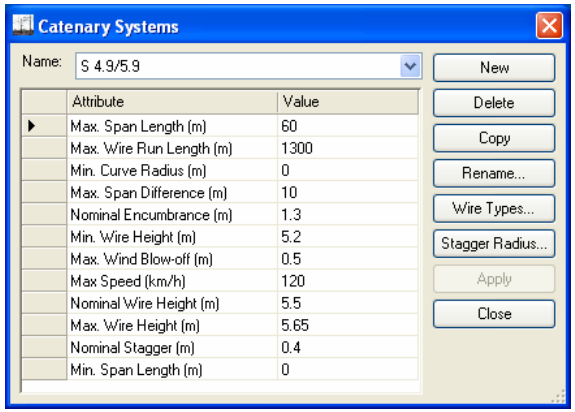
Design Process

- Reference lines
- Wire runs
- Connections
- Wire height and stagger
- Structures
- Other equipment



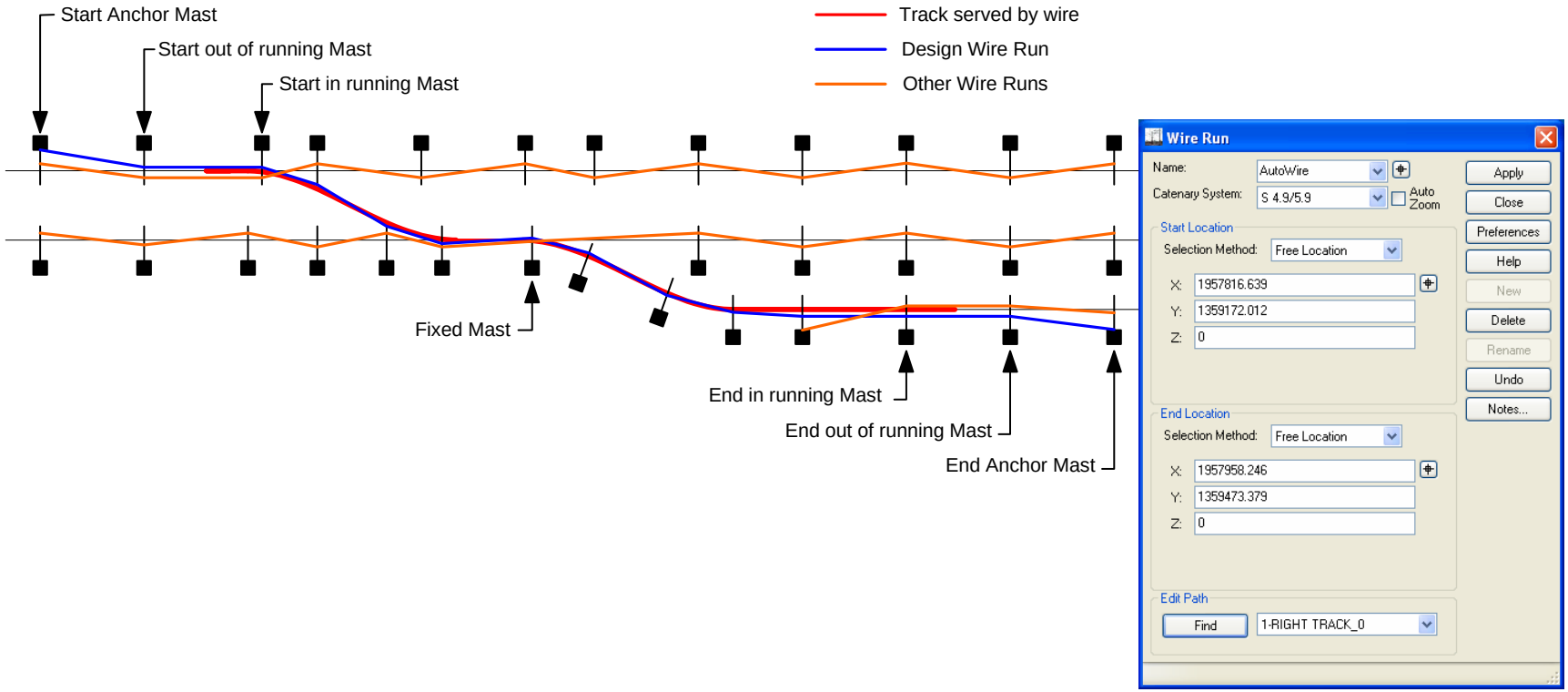
Reference Lines

- Place manually at known locations, relative to fixed locations, or automatically
  - Works around exclusion *zones* (i.e. underground utilities, etc.)



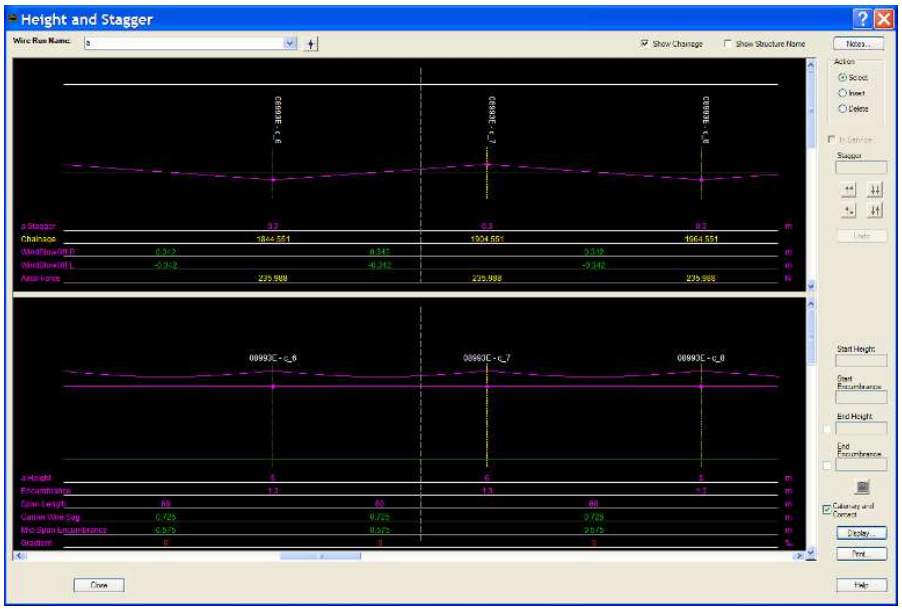
Wire Runs

- Wire runs associated with network track paths



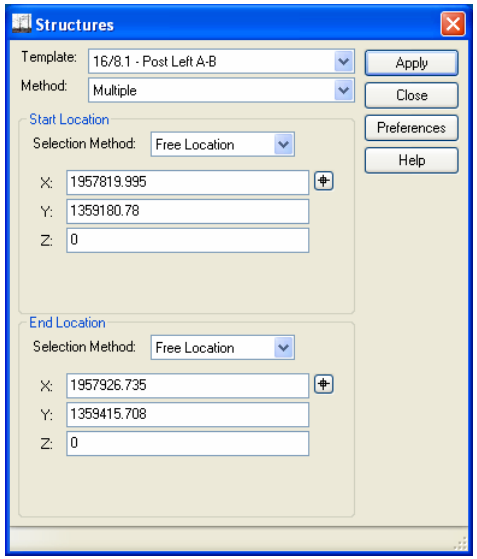
Height & Stagger

- Modify & edit wire staggers
- Automatically calculates
  - Wind blow off
  - Axial forces
  - Etc.
    - Display design violations!
- Customizable to specific railway standards!



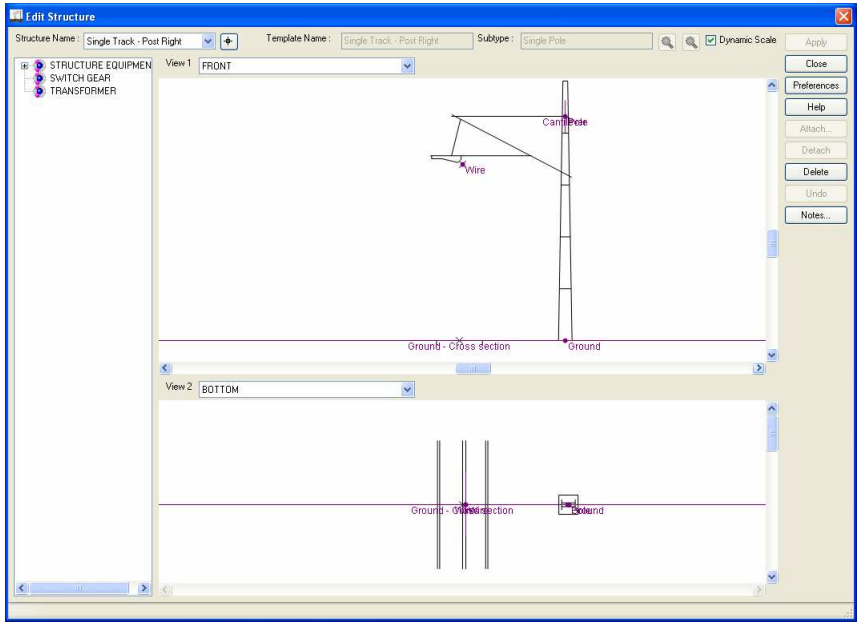
Structures

- Structures types include:
  - Mast – single
  - Portal
  - Assembly
- Create individually or in multiples
- Utilize templates



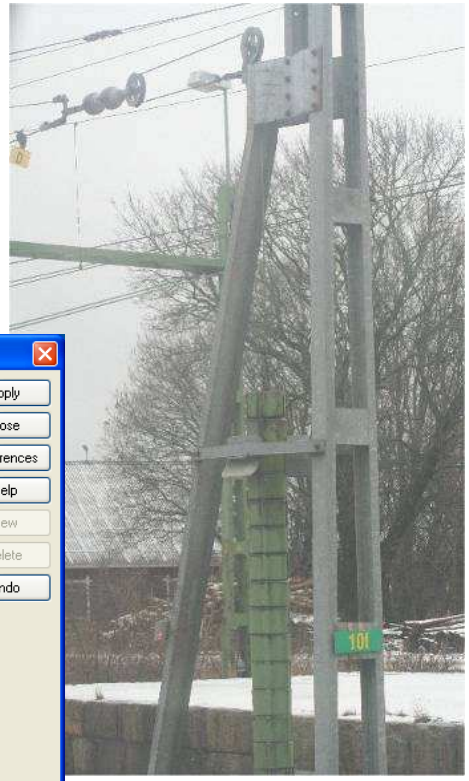
Templates

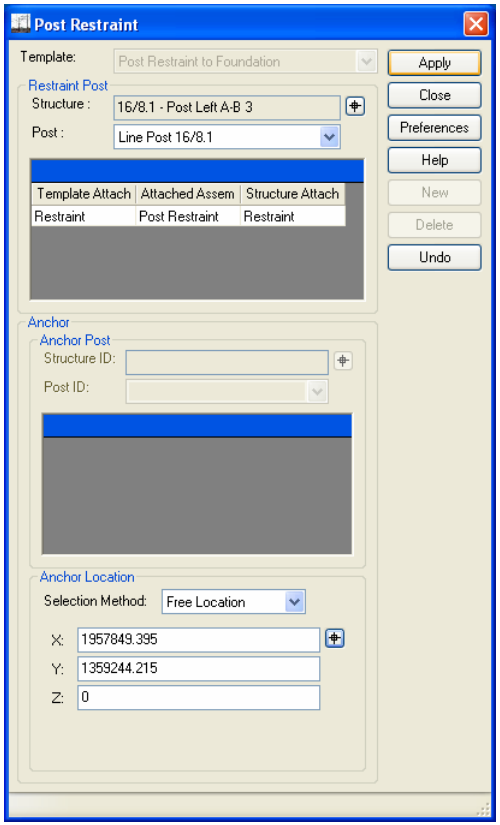
- Used for
  - Structures
  - In-span equipment
  - Wire tension equipment
- User defined Templates
  - Made of assemblies
    - Made of components
    - Graphic & non-graphic data
- Create once, use over and over!

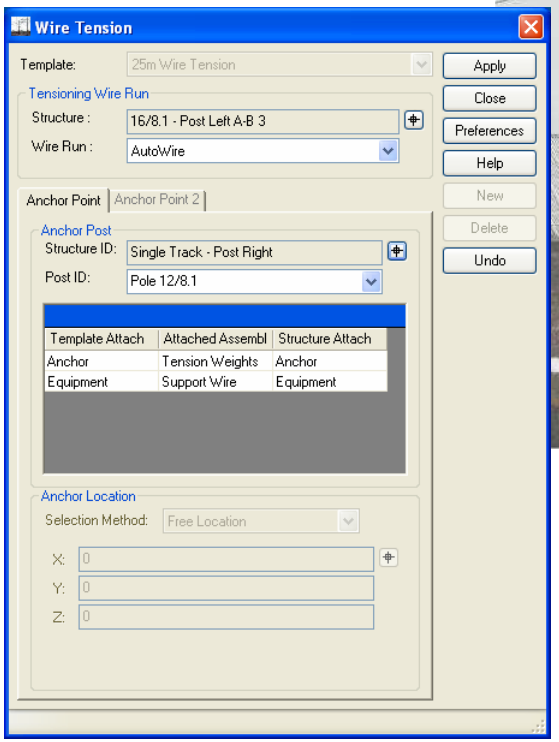


Wire Run End Conditions

- Mid-Wire Tension
- End Wire Fixity/ Tension





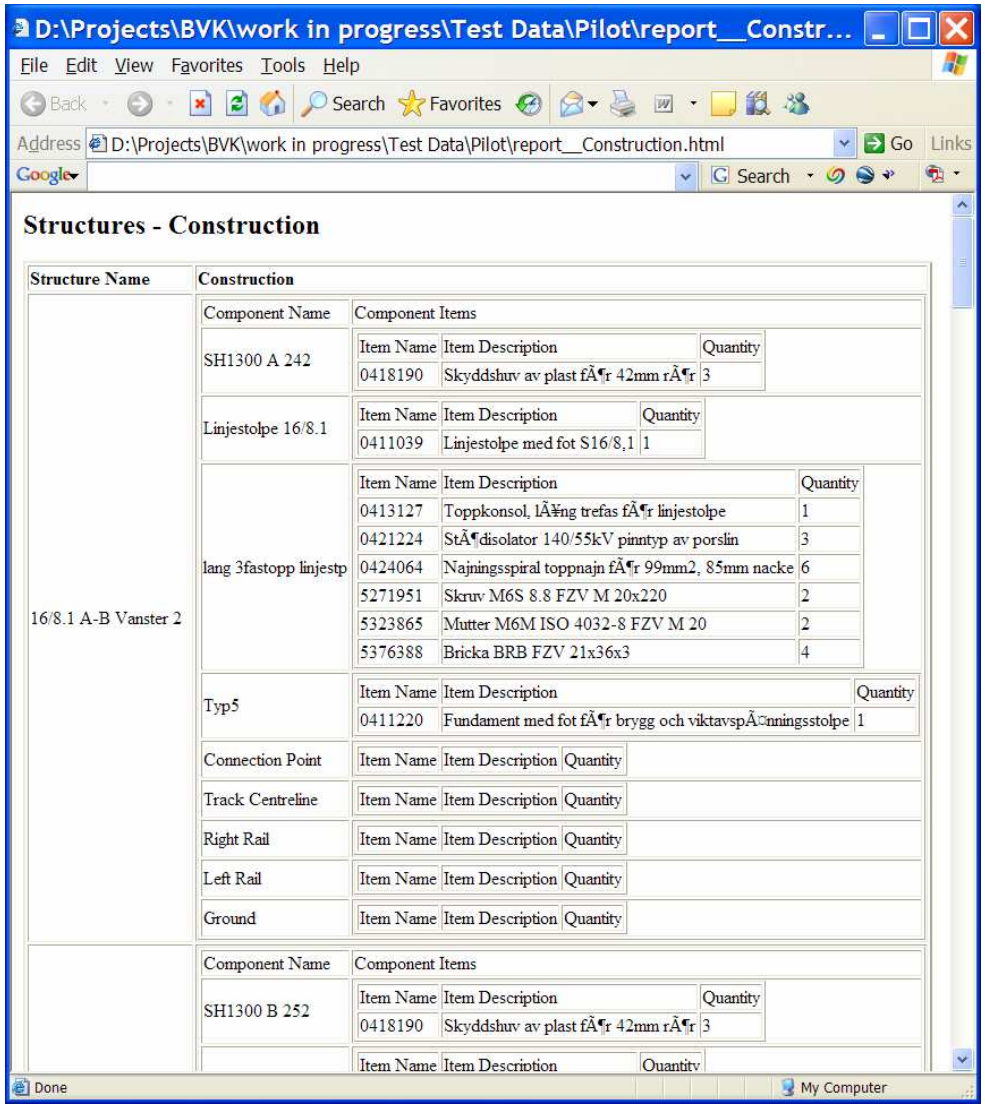


Other Equipment

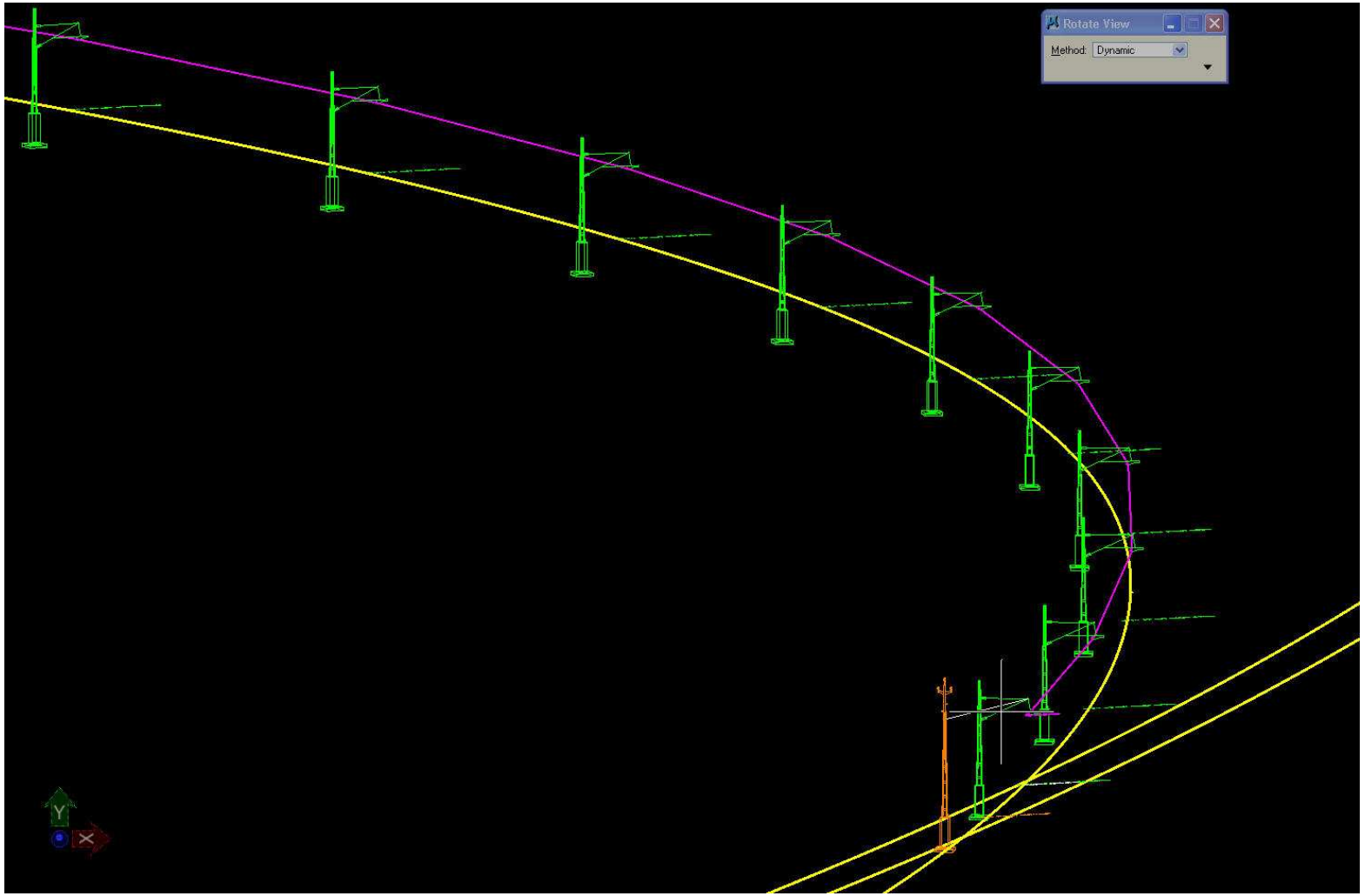
- Transformers
- Post restraints
- In span equipment
- Span bonding

Reporting

- Reports
  - XML / XSL
- Checking
- Bills of materials
- Equipment pick lists



Overhead Line Modeling…



Questions?