VI-Rail

With VI-Rail, engineers accurately model complete railway vehicles, then realistically simulate their design's behavior in motion. This lets users study, refine, and optimize railcar and locomotive performance — all on the computer, before running physical tests.

Using VI-Rail — the specialized railcar simulation software from VI-grade — an engineering team can quickly build a complete, parameterized model of a new railway vehicle, easily defining its suspension, wheelset, wheel–rail contact, and other vital characteristics.

Then, without leaving their engineering workstations, the team's members can run the model through a battery of kinematic, static, and dynamic simulations, using these tests to determine the vehicle stability, derailment safety, clearance, track load, passenger comfort, switch crossing and more.

What's key is that, with VI-Rail, this is all done on the computer. An engineering team can refine and optimize the performance of its railcar design before cutting a single piece of metal or running a single physical test and with that dramatically reduce cost in the development process.

VI-Rail's user interface is designed specifically for railway vehicle simulation. Menu selections highlight functions already familiar to rail engineers, so they can quickly become proficient with the software. VI-Rail can be customized to support unique modeling and simulation approaches.

Fast "what-if" Simulations

VI-Rail users not only work faster, they work smarter. Simulation gives users immediate answers to their engineering questions. They quickly see and understand how any kind of design change will affect vehicle performance.

Capabilites

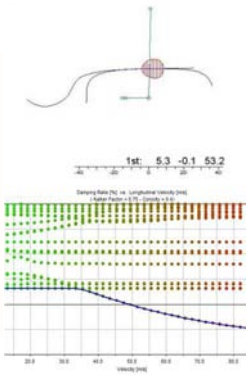
VI-Rail is an engineering environment for the simulation of rail cars and locomotives as well as tracks.

- The special **Wheel-Rail Contact Elements** accurately predict contact pressure and forces.
- The **Parametric Modelling** enables users to run fast "what-if" studies.
- The **Subsystem Architecture** separates complex tasks and provides an intuitive interface.
- The **Template Builder** helps to build new designs quickly and efficiently.
- The **Data Libraries** assure component standardization and allow easy data management.
- The **System Level Approach** helps the understanding of vehicle performance by cross-correlating all individual components.
- **Modelling** within the VI-Rail environment provides full support of several specialized modules for FEA, Hydraulics, Control Systems and other concurrent disciplines.
- The **Simulation Menu** allows for various types of events for complete virtual testing of the model.
- The **Plotting Environment** offers a convenient method for reviewing results in all their details.

Benefits

With VI-Rail it is possible to make design decisions in the shortest possible time at minimum cost, allowing you to:

- **Innovate** by trying out new ideas in the virtual world.
- **Save Time** in the testing process by shifting tests into the virtual world before cutting a single piece of metal.
- **Cut cost** by reducing the number of prototypes.

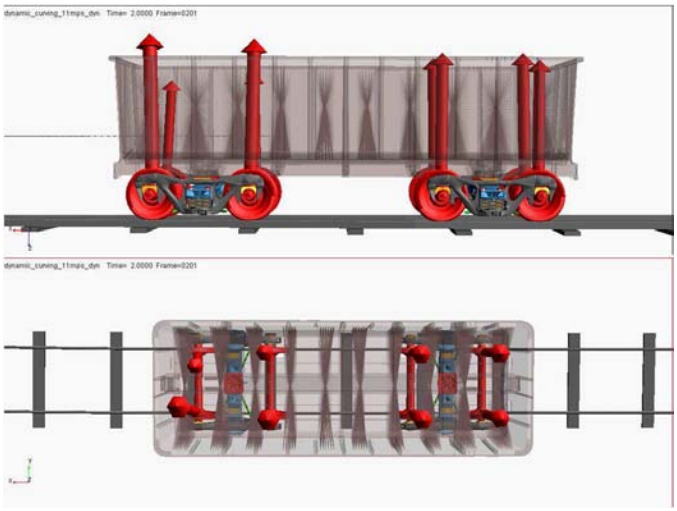


VI-Rail users can instantly see the effects of design changes on the performance of their vehicle in high–speed animation. They can easily detect component interferences, excessive wear, instability, and performance limitations. Users can also plot key parameters in graphs to compare results from different designs.

VI-Rail is built upon MSC Adams, widely recognized as the world's leading mechanical system simulation tool. VI-Rail extends users' ability to:

- Quickly build, test, and refine railcar designs, exploring many "what–if" alternatives. A user can, for example, change key locations, springs and other parameters with only a few mouse clicks, instead of having to wait for a mechanic to install new springs, as required with physical testing.
- Easily vary the kinds of analyses being performed. With simulation, there's no need to modify physical instrumentation, test fixtures, and test procedures.
- Work in a secure testing environment, without fear of losing critical data to instrument failure or falling behind schedule due to poor weather conditions for testing.

In the past, the time and cost of physical testing made multiple railcar design iterations impractical. Now, with VI-Rail, users can immediately see how their vehicle designs will move and where the potential problems are. They can plot their results in graphs or view them in high–speed animation.



Designed for and by Engineers

The development of VI-Rail began in 1993 when engineers at NedTrain Consulting, an off–shoot of N.V. Nederlandse Spoorwegen (Dutch Rail), conducted an evaluation of commercially available mechanical system simulation tools. The specialized simulation packages offered at that time for rail applications were judged to be unsatisfactory, most commonly due to poor or non–existent graphical user interfaces, difficult interaction with other computer–aided design and engineering (CAD/CAE) tools, and problematic results from non–standard calculations.

The best solution was determined to be customization of general–purpose MSC Adams software, which had been proven in use and progressively enhanced since its commercial introduction in 1980. Joint development of VI-Rail was soon initiated. The development drew heavily upon the theoretical work of Professors Kalker and de Pater of the Delft Technological University in the Netherlands. Embedded in the software were the specialized design expertise and analytical methods of rail engineers.

The experts behind it

In 1996, ArgeCare e.V. — well known in the field of railway dynamics for its popular MEDYNA software — joined the VI-Rail development consortium. The objective of ArgeCare was to incorporate their universally recognized competence in modeling of wheel/rail interaction within the frame of MSC Adams, taking advantage of the latter software's state–of–the–art graphical user interface, fully nonlinear dynamic solver, and industry–proven interfaces to leading CAD/CAE packages.

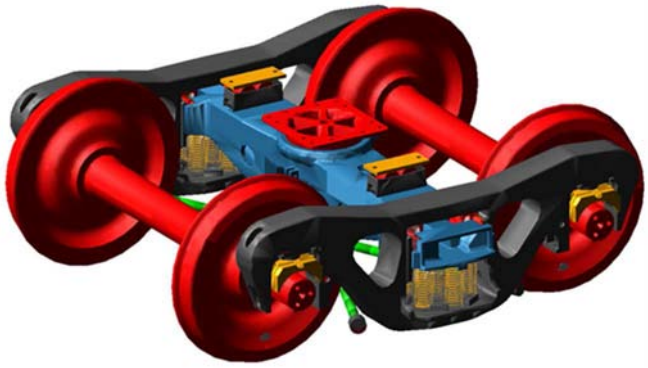
Subsystem-based architecture

Two separate user modes are available for VI-Rail users:

- A standard interface, which allows users to enter data into existing design templates to run both standard and custom design tests
- A template builder interface, enabling experienced users to create their own design templates from libraries of core and user–defined modeling elements

In template–builder mode, the user defines parametric model topology using the railway elements in the VI-Rail library (wheelsets, bogie frames, dampers, suspensions, etc.). Then, within the standard interface, the user can use the new templates and specify their data to create a fully functional model of a railway vehicle. Subsystems can be easily assembled into a complete railcar, or even a complete train including engine and cars. In vehicle modeling, users work at the system level, with a standardized platform, and the software's database structure allows easy data exchange.

VI-Rail Freight Toolkit



VI-Rail Freight is a plugin that offers a set of modeling elements, analysis procedures and postprocessing tools designed to address the specific needs related to dynamic simulation and virtual acceptance of freight vehicles.

VI-Rail Freight allows freight car manufacturers to easily assemble a parametric freight vehicle (for example a 3 piece bogie with cross-bracing), automatically performing all tests prescribed by the AAR Chapter XI regulations.

VI-Rail Freight features a library of typical freight bogie elements (including bolster, sideframe, center plate with 3d friction, bistop, side bearer, friction wedge) as well as several predefined simulation scenarios (hunting, constant curving, spiral, twist&roll, pitch&bounce, yaw&sway, dynamic curving) and postprocessing functionalities that enable the automatic generation of AAR-specific reports.

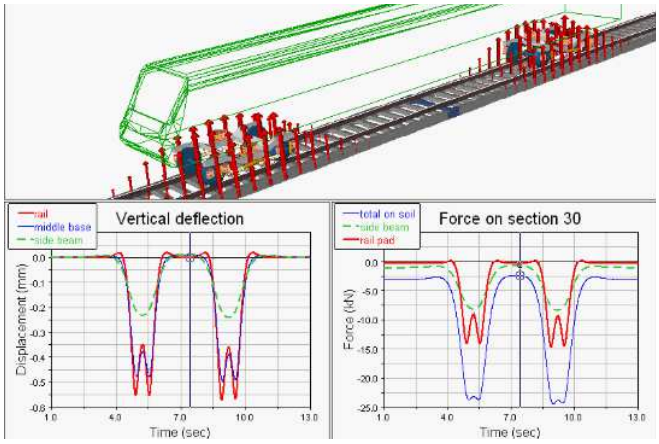
VI-Rail Wear Toolkit

The VI-Rail Wear Toolkit is a VI-Rail add-on that allows the prediction of wear during a dynamic analysis. During the simulation, the frictional power in wheel/rail contact is computed together with the changes in wheel and rail profiles due to wear. The wear computation is embedded in the advanced contact model available in VI-Rail; this leads to a smooth and seamless integration of the advanced wear predicting tool with the standard VI-Rail dynamic analysis.

Summing up multiple test cases (different track layouts, different vehicle conditions, different loads), it is possible to reproduce the conditions that represent the usage of a certain wheel or rail profile in the real world. Wear is quickly cumulated by the computation algorithm and allows to produce meaningful results with a pretty small number of simulations, leading to a very fast wear prediction, especially if compared to real-world measurements.

Finally, the Wear Toolkit has been validated with a two-step method: wear measurement for a certain period of operation has been used to adjust parameters of the wear module. A second set of measurement has been then used to validate the prediction obtained by the simulation.

VI-Rail FlexTrack Toolkit



VI-FlexTrack is a VI-Rail plugin that allows to create complex track models that include general models of the flexibility of the rail and of the railway infrastructure. VI-FlexTrack enables to properly model the interaction of a vehicle with the railway, for example when running over a flexible bridge.

VI-FlexTrack plugin gives to the user a set of features that allow to build a full flexible track template through highly automated procedures. A flexible track template can contain flexible rails represented by means of:

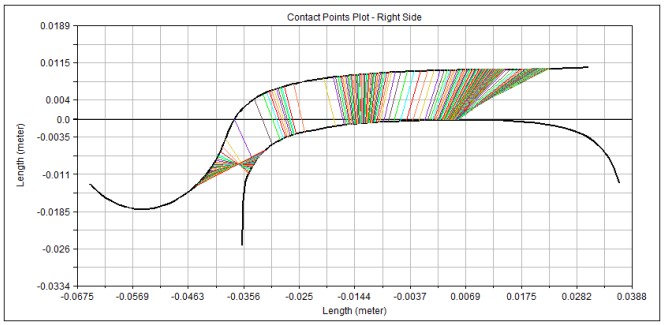
- MSC Adams beams: In this flexible track model the rail is represented by lumped masses (positioned at each sleeper), connected through massless beams.
- Flexible bodies: the procedure is interfaced with MSC.Nastran and allows the automatic generation of the MNF files using a track layout specified through a standard VI-Rail track property file.

VI-FlexTrack is based on the Template Builder technology, with which it is possible to assemble standard components, such as parts, joints, springs, bushing, etc. and in this way to define the architecture of the vehicle. VI-FlexTrack also features specific components (such as a beam-based and an MNF-based sleeper model) to be added to the VI-Rail Template Builder environment.

VI-Rail Stress Toolkit

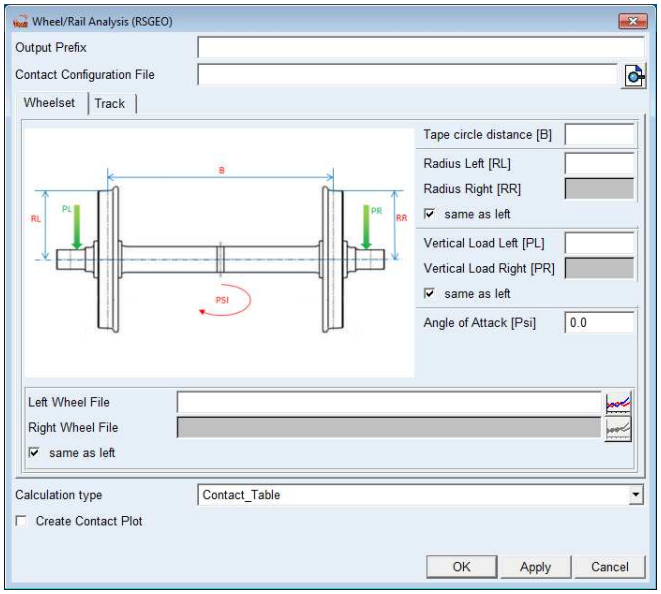
The VI-Rail Stress Toolkit is a VI-Rail add-on that allows the computation of surface stresses at wheel/rail contact interface, as well as subsurface stresses distribution in wheel and rail material in proximity of the contact patch (based on the Boundary Element Method developed by J. J. Kalker).

The data needed for stress computation are generated by the contact algorithm during the dynamic analysis. Snapshots of the wheel-rail contact are taken at user specified positions during the dynamic analysis and are stored in ASCII files. The postprocessing of these files is performed trough the ArgeCare Stress Analysis program, which produces output in tabular and graphical formats.



Key Topics of v16 Release

- Modeling Enhancements
- Shear spring model has been enhanced (solved issues due to unit dependency)
- Analysis Enhancements
- C++ solver is now the default in VI-Rail.
- Results file is the new default format for VI-Rail.
- Added possibility to run the vehicle with negative initial velocity, allowing to better analyze asymmetric vehicles.
- Preload analysis reviewed to avoid long simulation/ processing time on model with bushing elements.
- RSGEO input dialog box enhanced; added visualization of contact point on wheel/rail profile using colored lines.
- Documentation Enhancements (Tutorials)
- Added step-by-step tutorial on how to use VI-Rail in co-simulations with Matlab Simulink usingADAMS/Controls
- Added a new tutorial on how to run a VI-Rail model with initial negative velocity
- Added step-by-step tutorial to build a flexible track with generic infrastructure, using interactive or scripted mode.
- Postprocessing Enhancements
- Added evaluation of instability criterion (EN14363)
- VI-Rail Freight Toolkit:
- Added load sensitive friction wedge
- Updated friction force definition, producing non-zero fric tional force when normal force is null
- VI-Rail Wear and Stress:
- Added support for variable profile (allows to evaluate wear differently on different sections of track)
- Wear toolkit output names now match the input file names, for easier interpretation of results
- Enabled possibility to cumulate wear on multiple wheels with same profile
- VI-Flextrack.
- Added the possibility to generate flexible track with generic infrastructure, as an alternative to the ballasted track already available.



VI-Rail Elements Library

Model Elements:

- Wheels and wheelsets
- Single element with symmetric building option
- Bogie frame with parameterized geometry
- Axle box (symmetric, anti–symmetric)
- Car body (engine, wagon)

Interconnections:

- Suspension elements
- Linear vs. non linear bushings
- Linear vs. non linear dampers with series stiffness
- Bumpstops
- Airsprings — linear or nonlinear and single or coupled
- Torsion springs

General Elements:

- Parts (rigid and flexible)
- Joints
- Friction elements (translational and rotational)

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