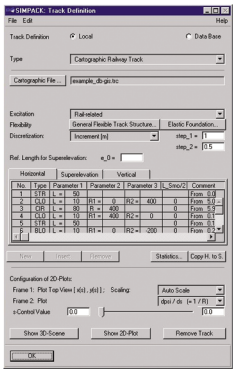
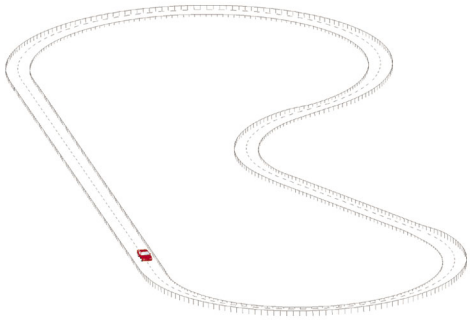
Gerhard Hippmann, Mark Duke
INTEC GmbH

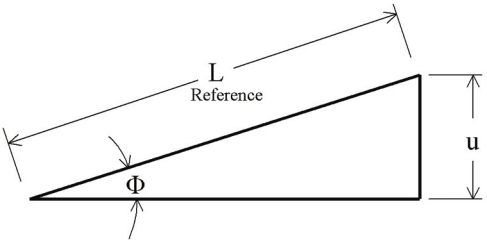
Advances in Track Modelling



Graphical user interface for the track module



Automotive track



Defining tracks: superelevation and transverse slope

Track models are an essential feature for Wheel–Rail applications and often used in the simulation of Automotive models. The SIMPACK track module provides various types of track modelling for both these areas of application. Today's vehicle simulation requires more and more sophisticated modelling, which has necessitated enhancements to the SIMPACK track module, which will be released with the next SIMPACK versions.

There are three track types available within SIMPACK: *Standard Tracks, Cartographic Tracks and Measured Tracks*. The Standard Track enables the user to define standard manoeuvres, e.g. curve entries or crossovers, using only a few parameters. More complex tracks of arbitrary structure can be modelled using Cartographic Tracks. In addition, Measured Tracks allow tracks to be generated from measured track data. The new developments in the track module relate to the Cartographic and Measured Tracks.

CARTOGRAPHIC TRACKS

Up to now Cartographic Tracks were built up of ensembles representing the horizontal, vertical and superelevation sections separately. This allowed relatively complex tracks to be modelled. However, some high-end Wheel-Rail applications met the limits of the current implementation.

The new Cartographic Track consists of elements instead of ensembles. A horizontal ensemble is identical to a series of four track elements, a straight line element followed by a clothoid element, a constant radius element and finally another clothoid element. In contrast to the ensemble based definition, track elements may be defined in any arbitrary order and without restriction to the boundary values, made possible with the use of arbitrary length Hermite polynomials to smooth discontinuities.

The increase in flexibility is counterbalanced by track elements of new geometrical types. For the horizontal and superelevation track definition, *Bloss* and *Sinosoid* curves are available. Another new track element models quadratic parabolas in the vertical direction. The concept of representing tracks with MBS-elements allows new curve types to be implemented with ease.

Because the maximum number of Cartographic Track elements is defined in the user- or model-specific dimensions file, the user is no longer restricted when modelling long tracks, which is especially useful for durability analyses.

Cartographic Tracks can also be defined using an ASCII file; this file is written in a keyword based format and provides the full SIMPACK functionality. In addition, files containing a subset of the common *DB-GIS* track description data can be used to generate Cartographic Tracks.

MEASURED TRACKS

Similar to Cartographic Tracks, some SIMPACK users required more functionality from the Measured Tracks. Up until now, this type of track read-in a binary file containing data points used to interpolate the functions defining the horizontal curvature and the superelevation.

The new Measured Track provides considerably more functionality, with three new ASCII file formats specified. The file formats contain all of the data required to satisfy the needs of today's vehicle simulation engineers. The first format is similar

Gerhard Hippmann, Mark Duke
INTEC GmbH

to the old method, describing the track by curvature functions. However, SIMPACK now considers an additional function of the vertical curvature, which takes into account all of the degrees of freedom.

It often occurs, that the Measured Track is determined by Cartesian co-ordinates x(s), y(s), z(s). SIMPACK offers this type of track definition in two slightly different formats. Whilst one represents the roll angle superelevation from data points, the other uses the transverse slope (explained in the image on the left). Measured Tracks in a Cartesian representation also support closed loops, whereby if the first and the last data points are identical the simulated vehicle may run multiple laps on a test track.

Last but not least, the new file formats contain keyword-based headers which allow data to be used with any set of units as well as allowing an increment to be defined, which reduces the number of data points within SIMPACK. The headers can also be used to set the type and reference length of the superelevation.

The new track developments provide a substantially extended flexibility and functionality, confirming SIMPACK as the vehicle simulation tool for the future.