

# SIMPACK News

VOLUME 9, SECOND ISSUE

OCTOBER 2005



*Jordan EJ15 at the USA GP*

## SIMPACK Use at Jordan Grand Prix

For a small Formula One team such as Jordan Grand Prix, dynamic simulation tools, in particular SIMPACK, are increasingly helpful in understanding the effects of design changes prior to track testing.

Track testing of performance parts has become much more a validation process than a learning process, and unproductive development 'paths' can be avoided through effective CAE work using the latest MBS techniques. Jordan, (to be re-named Midland F1 by mid-November) has been using SIMPACK for just over 18 months. Despite the steep learning curve associated with using any MBS software tool,

there have already been a number of SIMPACK- led developments on the car. More importantly the work undertaken has enabled the Vehicle Dynamics group to understand more fully the areas of tyre use and suspension kinematics and compliance effects, and to feed this knowledge into the design process.

### MODEL ARCHITECTURE

All models share a common chassis substructure, which possesses the mass and torsional stiffness properties of the monocoque, engine and gearbox, as measured by rig testing. The suspension substructures are split into three groups, rigid suspension geom-

etry, compliant geometry and virtual suspension geometry. The latter utilises a Virtual Suspension Table (Joint Type 94), to implement the kinematics and compliance from a series of look-up tables. This can be particularly useful for testing kinematic characteristics in isolation. Virtual Suspension models also have the advantage of being particularly fast to solve, due to the lack of constraints in the suspen-

### » CUSTOMER APPLICATION .....01

*Richard Frith, Jordan Grand Prix*

SIMPACK Use at Jordan Grand Prix

### » SIMPACK PLOT MODULE ..... 04

*Dr. Wolfgang Trautenberg, INTEC GmbH*

Customizing and Scripting SIMPACK

### » SIMPACK CHAIN MODULE ..... 06

*Marcus Schittenhelm, INTEC GmbH*

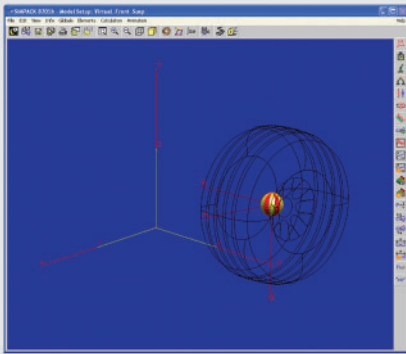
New SIMPACK Chain Module

### » SIMPACK TIPS AND TRICKS ..... 09

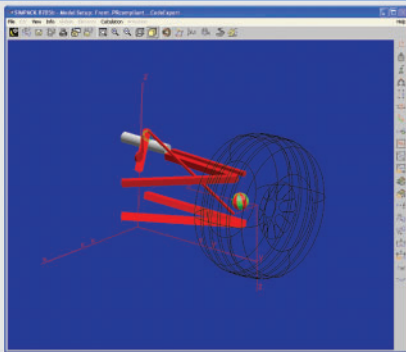
*Steve Mulski, Dr. Christoph Weidemann, INTEC GmbH*

Expressions

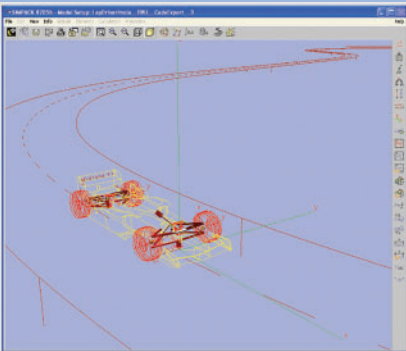
Richard Frith,  
Jordan Grand Prix



*Virtual Suspension Corner Model*



*Standard Suspension Corner Model*



*Lap Driver out on Circuit*

sion sub-system. The fact that virtual suspension models can be solved by ODEs rather than DAEs (as with a constrained model), is particularly useful when linking models to Simulink (see Code Export below).

Accurately reproducing the aerodynamic forces and moments is fundamental to F1 CAE work. These characteristics are mapped from wind tunnel data as functions of dynamic air pressure and front and rear ride heights. In addition to straight-line effects it is also possible to account for the sensitivity of the aerodynamic forces to vehicle yaw and steer, as the precise airflow direction and angle of the steered wheels can greatly influence the magnitude and distribution of the aerodynamic forces on the car.

Arguably the most critical part of the full car model is the tyre implementation. A close collaboration between Jordan and its tyre supplier Bridgestone over the past 12 months has helped the team gain a greater depth of understanding of the data supplied from Japan. As a result of this, tyre models have been developed which address some of the fundamental problems associated with replicating the characteristics of these complex components. In addition, validation processes between track test data and the CAE environment are in constant development.

#### STANDARD SUSPENSION GEOMETRY

The standard suspension geometry models each part of the suspension individually. This has the advantage that all the individual forces going through the suspension members (including internal components) will be calculated. As the models are fully parameterised, it is quick and easy to make small modifications to the geometry and study its effects. To predict the compliance effects of the suspension, the wishbones and other suspension members are modelled as flexible bodies using SIMPACK's FE-interface FEMBS. This provides an ideal model to calculate the overall compliance of the suspension, as this is not

only a function of the stiffness of the individual suspension members, but also very much a function of the suspension geometry.

#### VIRTUAL SUSPENSION GEOMETRY

The virtual suspension joint type 94 is used to model the kinematics and compliance of a suspension using look-up tables. The kinematic data required is generated by performing a bump and steer sweep (in case of the front suspension) using the standard suspension models. This is done within the parameter variation module which automatically creates the required look-up tables in a SIMPACK format (afs-file). The compliance is taken from an R&D test and input as a function of contact patch loads. The resulting model is very quick and is suitable for real-time applications.

#### TEST TECHNIQUES

Using basic data taken from the car (Glat, Vcar and lap distance) it is possible to recreate the path followed by the car in SIMPACK, describing the track in the form of horizontal and vertical curvatures with camber, as a function of lap distance. Sensors are used that can measure the positioning of the car relative to the track as well as the deviation at certain preview distance. This is fed into a control model that will control the steering; engine and brakes enable the model to replicate an exact outing.

Alternatively tracks are defined using cartographic functions within the SIMPACK Automotive module. Full vehicle testing is performed on such tracks either by means of a closed loop path following steer controller or by open loop inputs, for example in the case of a step-steer analysis. Many of the tests performed are variations on industry standards and include j-turns, constant radius, constant acceleration, lane changes and swept steer manoeuvres.

Driver modelling techniques require a different approach, as the difficulty lies in driving the car at the limits of tyre performance. This capability is

Richard Frith,  
Jordan Grand Prix

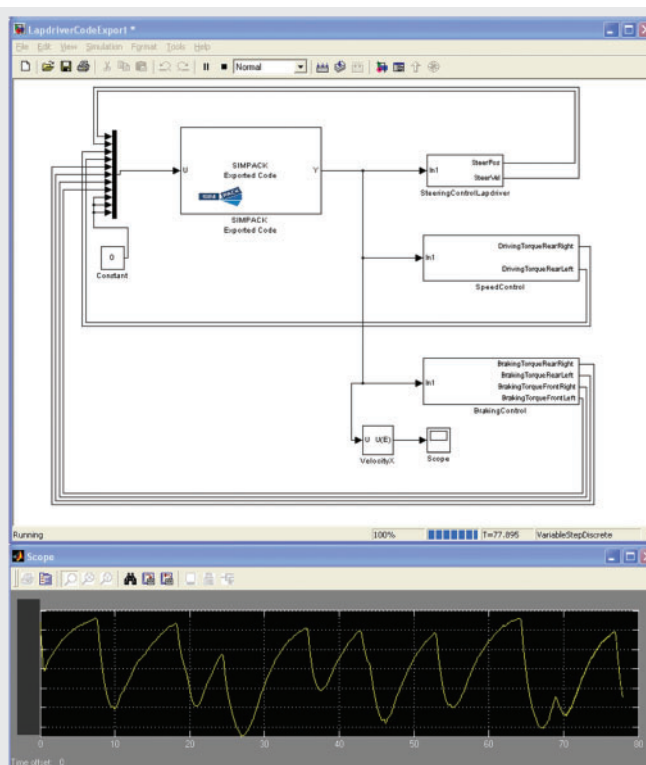
something that the Vehicle Science department is continually developing; the use of Code Export conveniently allows access to the comprehensive capabilities of Matlab and Simulink, an environment which the engineers are very familiar with. The outcome of this work brings with it great benefits in the assessment of performance as a lap time change, rather than as an improvement in more qualitative chassis metrics.

### CODE EXPORT

Jordan has recently purchased the Code Export feature from INTEC, to enable models to be run as S-Functions in the MATLAB/Simulink environment. Code Export brings proven SIMPACK chassis dynamics models into a computing medium which is used in common by the chassis dynamics, control and race engineers. It not only gives the control engineers access to more detailed dynamic models for control system work specifically, but it also allows the chassis dynamics group to utilise the existing on-car control system code in ride and handling simulations.

### THE FUTURE

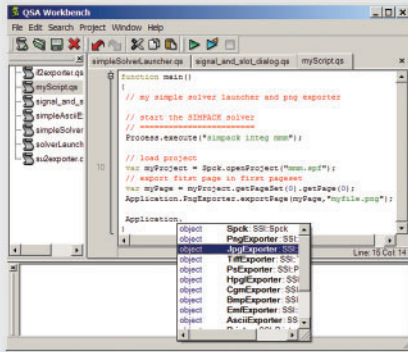
The design for the 2006 car, known as the M16, has taken place in a relatively short time period due to the many changes and uncertainties that come with a change of team ownership. An MBS package with the capabilities to produce answers quickly and accurately has been fundamental to making design decisions quickly. With careful use of full-vehicle dynamic simulation tools such as SIMPACK, combined with a solid scientific approach to testing both at the track and in a CAE environment, the team is now optimistic of improving its pace relative to its main competitors in 2006.



Simulink Model Containing  
the Code Export S-function

Dr. Trautenberg,  
INTEC GmbH

# Customizing and Scripting SIMPACK



*Integrated Development Environment for Generating Scripts within SIMPACK*

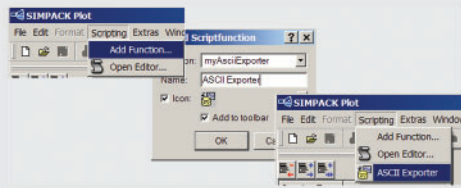
Beginning with the new SIMPACK Plot module, INTEC is introducing an all new scripting engine to SIMPACK. The scripting engine is based on QSA, an object oriented scripting language similar to JavaScript. Not only is QSA tightly integrated with the new architecture, it is also an important foundation of it bringing application customizing to a new level. It allows the user to define and perform batch tasks, to write macros for repeated tasks as well as to define complete custom graphical user interface (GUI) windows.

In addition QSA is also used for defining intelligent „live texts“ as well as when entering element parameters. To facilitate easy generation of those scripts, SIMPACK comes with an integrated scripting development environment (IDE).

ess handling and a set of classes and objects for generating graphical user interfaces (GUI). Furthermore, INTEC has expanded the language to enable the customers to access SIMPACK specific objects and functionality, such as accessing the value pairs of a curve or exporting a plot page to a bitmap file.

## DEVELOPMENT ENVIRONMENT

Generating and testing scripts in a standard ASCII file editor can be a tedious job. To simplify and speed up this task an Integrated Development Environment (IDE) for writing and testing scripts has been included into SIMPACK. This IDE, which is called QSA Workbench, has state of the art productivity features for generating scripts such as syntax highlighting, automatic indentation, bracket check, code completion and automatic parameter list display. The latter two features being extremely useful since they free the scriptor from having to look up each single statement in the documentation and reduce the probability for errors in the script code.



*Adding a Macro to the SIMPACK GUI*

## WHY SCRIPTING?

The new SIMPACK GUI offers a wide range of features for increasing the productivity in day to day work. In addition to that, scripting has been added directly to the new SIMPACK GUI. It enables the user to customize the SIMPACK GUI to specific needs, to add user specific functionality and to automate processes by implementing and executing batch tasks. Typical applications for scripting are user specific ASCII plot curve exporters or a custom GUI dialog for modifying a set of parameters, launching the SIMPACK solver and viewing the results. The functionality made available to the user by integrating the scripting language is explained in this article.

## AUTOMATING YOUR PROCESS

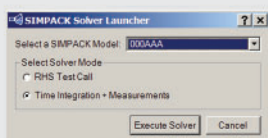
Once simulation models are created and verified quite often complex simulation scenarios and parameter studies are performed. The scripting language allows to automate these processes by enabling the user to execute the SIMPACK solver, start external processes, read and write ASCII files as well as to export the generated results either as ASCII data, as bitmap or as vector graphics files. Of course SIMPACK's QSA workbench can be used for generating and testing these batch scripts. Naturally with a batch script it is possible to run these scripts without the SIMPACK GUI ever appearing on the screen, in the so called silent mode.

## SCRIPTING CONSOLE

The scripting console is a command line for entering and executing script commands from within the SIMPACK GUI. It enables the user to perform GUI tasks such as sending a plot page to the printer by entering a script com-

## THE LANGUAGE

The scripting language used throughout the new SIMPACK GUI architecture is QSA which is an Acronym for QT Script for Applications. QSA is object oriented and has a C/C++ style syntax. It adheres to the international ECMAScript 4.0 standard, the same standard used by Netscape's JavaScript and Microsoft's JScript. In addition to the standard QSA has some application customizing specific functionality such as file and directory handling, proc-



*Custom GUI Defined by Script Code for Launching the SIMPACK Solver*

mand rather than using the respective pull down menus or icons. The scripting console comes with the same set of script generation features as the QSA workbench, described above.

### MACROS IN THE SIMPACK GUI

Once the user has generated a specific script, e.g. a custom ASCII exporter which exports curve values in a user specific ASCII format, and has saved this script in the SIMPACK script database it can be reused. One way of reusing the script would be to load it into the QSA Workbench and to execute the script from there. Although this is a good approach while the script is under development, it would be cumbersome to have to do it this way each time a script should be used. Therefore INTEC has introduced the possibility of registering a script to the SIMPACK GUI. Doing so provides access to this script in the Script pull-down menu as well as in the Scripts toolbar where the script can be represented by a user provided icon. Thus a new macro can be added to the SIMPACK GUI.

### GENERATING CUSTOM GUIs

One of the distinct features of the new SIMPACK scripting engine is the possibility to expand the SIMPACK GUI with sophisticated custom GUI windows. The custom GUIs can range from simple dialogs, such as querying the user for selecting a file, to more elaborate dialogs, e.g. a dialog for specifying the export settings of a custom ASCII file exporter. Even complex dialogs, such as a custom GUI, that lets the user select between a set of pre-built simulation models, offers the ability to change parameters, to choose between pre-defined solver options, start the solver and view the results.

### BRINGING LIFE TO YOUR TEXT INPUTS

Texts which the user has entered in the GUI, e.g. an annotation text showing the maximum value of a curve, are typically static texts, which have to be updated manually once the element they are describing changes. The SIMPACK scripting engine can bring life to these

texts making them update according to the property they are describing. To achieve this script code can be embedded into the description text thus making it a „Live Text“.

### SCRIPTING „IN PLACE FORMULAS“

The scripting can even be used in less obvious places, such as when defining the parameters of a SIMPACK modeling element, e.g. a filter. Typically only numbers and Substitution Variables (SubVars) can be assigned to element parameters.

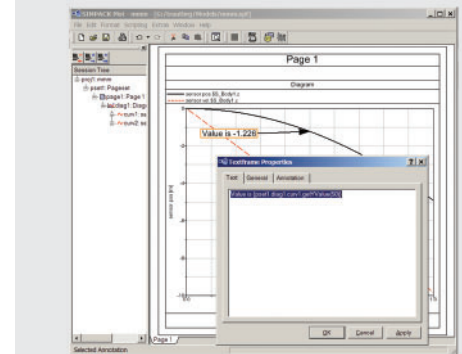
By utilizing the math and data access capabilities of the scripting language SIMPACK now offers the possibility to define and use „in place formulas“ when specifying parameters. Instead of having to manually compute the value of mathematical PI divided by two and then entering the resulting value for the parameter, the user can now simply type „PI/2“. Of course access to SubVars is also available when using these „in place formulas“. Please note that this functionality is currently only available for elements accessible in the new SIMPACK Plot GUI.

### SCRIPTABLE FUTURE

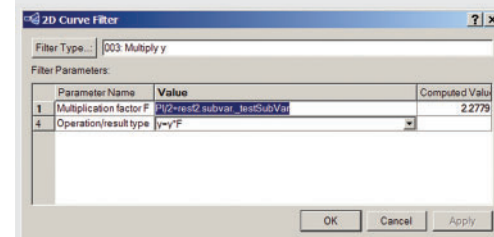
In addition to the discussed features future SIMPACK versions will have an even more enhanced scripting environment. A fully blown script code debugger and a utility for macro recording, i.e. recording user actions and automatically generating script code reflecting those actions, are on the roadmap for scripting. So is extended read and write access to properties of SIMPACK objects, such as the possibility to generate diagrams and curves using the scripting language.

### AVAILABILITY

Scripting and performing batch jobs with the new scripting language have been available since SIMPACK version 8.709. The Scripting Console, Macros, GUI customisation and the Scripting IDE will be available with the next SIMPACK version due in November 2005.



*Annotation Definition by Using „Live Text“*



*Specifying a Filter Parameter by Using „In Place Formulas“*

# New SIMPACK CHAIN Module

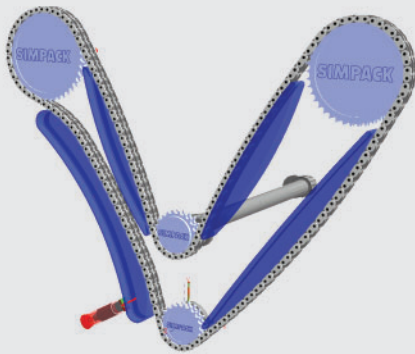


Figure 1

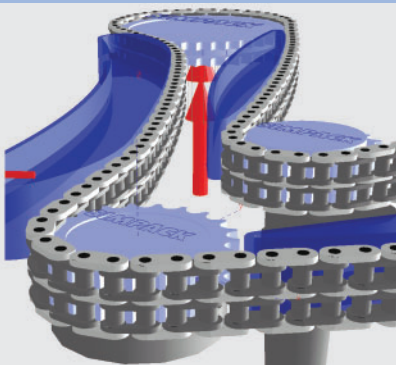


Figure 2

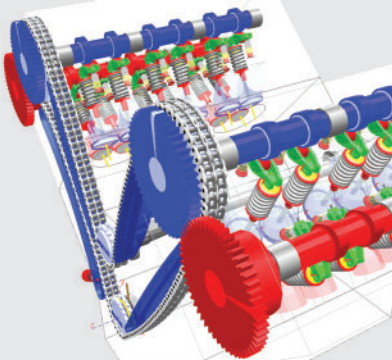


Figure 3

With SIMPACK Version 8.709, the first official release of a new high end chain simulation module has been made available. The CHAIN module uses SIMPACK's well known and verified relative co-ordinate algorithm, together with several completely new approaches. This has brought impressive calculation performance and result accuracy both with stand-alone chain models (Figure 1-2) and highly detailed complete engine models (Figure 3).

It is well known that specialised simulation tools have been available for the accurate and calculation efficient modelling of highly detailed chain systems. The SIMPACK CHAIN module offers, for the first time, comparable performance in a general multibody simulation program. This has been made possible due to the relative co-ordinates algorithm in SIMPACK, which is fully exploited and has been enhanced for the calculation of chain systems. In addition, the available calculation methods in SIMPACK have been optimised and combined for chain systems – hybrid solver using explicit and implicit techniques. A particularly important feature, as always in SIMPACK, is the avoidance of using solver 'black box' settings (e.g. numerical damping) and ensuring that the solver is numerically stable. These features have made it possible for SIMPACK to simulate detailed chain systems with the accuracy achieved by the 'best in class' chain specialised tools. This module has been seamlessly incorporated into the standard SIMPACK architecture. Individual chain models can therefore be easily changed and extended, and using the SIMPACK 'Substructures', can be integrated into entire engine models.

## MODEL APPROACH AND INCLUDED EFFECTS

The important features of the new SIMPACK chain module include a highly developed pre-processing to ensure the optimised generation of

the equations of motion and specialised GUI for the definition of the chain parameters and initial conditions. In addition the optimised calculation of the complex contacts are performed via a 'multi-force' Force Element.

The first release of the chain module offers the following functionality:

- Roller and bushed roller chains (figure 4)
- Chain wheels with the geometry definition according to DIN 8196 (figure 7)
- Rigid tensioner guides with the profile defined via arcs
- Generation of chain links as MBS elements with either 2 or 3 degrees of freedom
- Contact, clearance and friction between the chain links
- Contact and friction between the links and guides
- Contact and friction between the wheels and guides
- Detailed chain tensioner model, described via geometry and oil and mass characteristics with consideration of the plunger and valve-ball dynamics (figure 5)
- Chain post-processing output values

These features are important so that certain effects can be simulated:

- Polygon effect (figure 6)
- Changes in the link longitudinal velocity
- Changes in the link lateral velocity
- wheel run-in collisions
- Rotational collisions by wheel run-in and run-out
- Centrifugal forces
- Input and output torques
- Elongation

The following features are currently under development and shortly to be available:

- Toothed chains
- Flexible tensioner guides, generated in SIMBEAM or imported from complex FE models, which allow the contact force to be applied into the flexible body – similar to the SIMPACK flexible contact

- unround chain wheels

### MODEL GENERATION AND OPERATION IN SIMPACK

The interactive assembly and generation of the chain is performed using a specially developed graphical interface (figure 9). The sequence in which the chain is to run over the wheels and guides is entered. The ideal chain path is then automatically calculated from the entered chain components, including the link geometry and, if desired, an applied pre-loading of the chain. The chain links can then be automatically generated and positioned with the help of the idealised chain path and assigned their respective initial conditions. This ensures that the use of relative co-ordinates is optimised, as well as allowing the initial conditions to be easily and efficiently defined. When the solver is then started the chain steady state is quickly achieved.

The generated chain model can be used as a stand-alone chain simulation model. In addition measured crankshaft rotational eccentricities and camshaft fluctuating moments can be applied as boundary conditions to the chain. If this modelling does not provide the required accuracy then the interaction of the chain with valve- and crank-gear can be considered by loading the chain into an entire engine model. This can be easily performed by loading the chain as a SIMPACK 'Substructure'. Even these highly detailed and complex engine models can be solved due to the SIMPACK relative co-ordinates algorithm and through the development of the specialised chain numerics (hybrid solver). This results in excellent calculation performance in both efficiency and accuracy. The following model describes how the SIMPACK chain module has been verified and gives an insight into how well the solver performs.

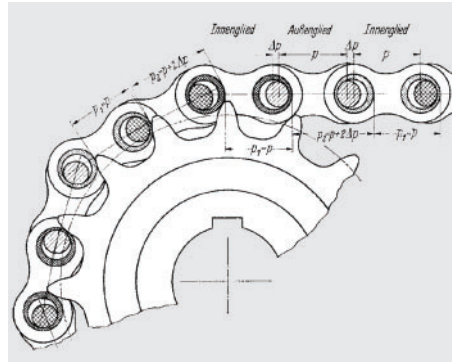


Figure 4



Figure 7

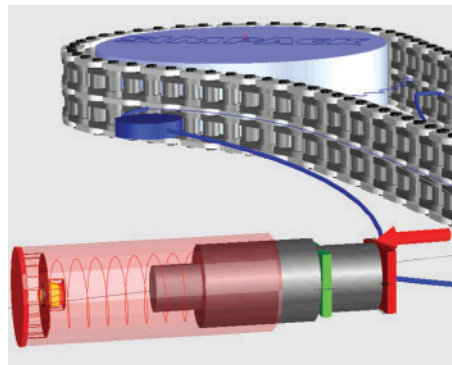


Figure 5



Figure 8

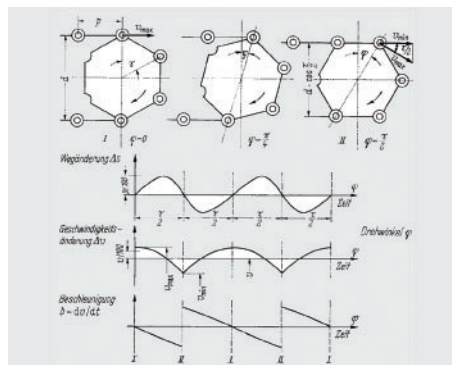


Figure 6

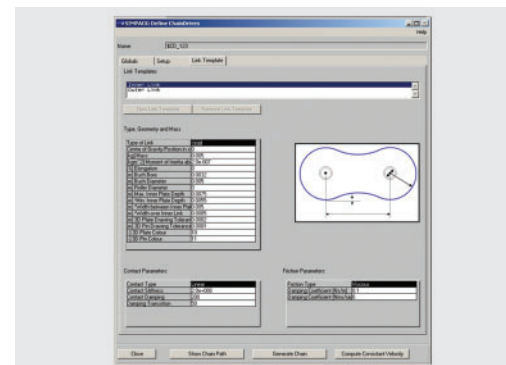


Figure 9

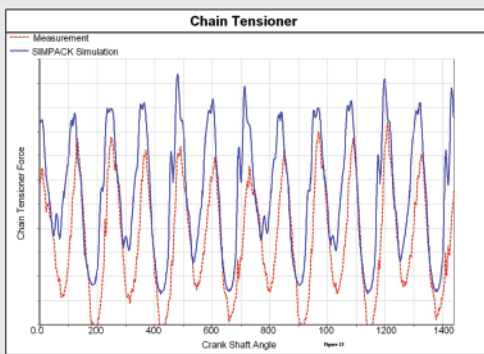


Figure 10

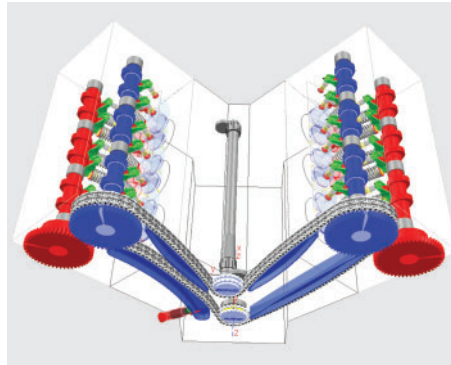


Figure 13

#### OEM VERIFICATION MODEL

The chain simulation verification model (figure 13) is an entire engine model offering complete interaction of the chain with the valve train. The model contains the following components:

- 29 flexible Bodies
- Approximately 1550 rigid Bodies
- Approximately 3400 states
- Chain with 3 degrees of freedom per link
- 24 detailed hydraulic lash adjusters with ball dynamics
- Detailed chain tensioner with ball dynamics
- Hydrodynamic bearings on the balancer shafts and camshafts

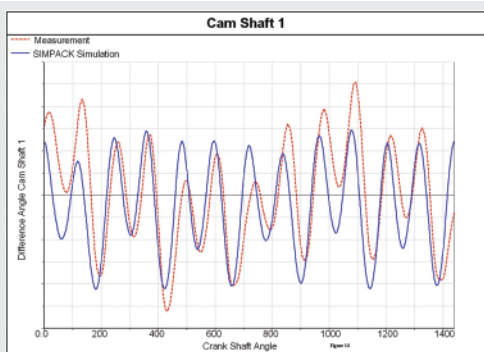


Figure 11

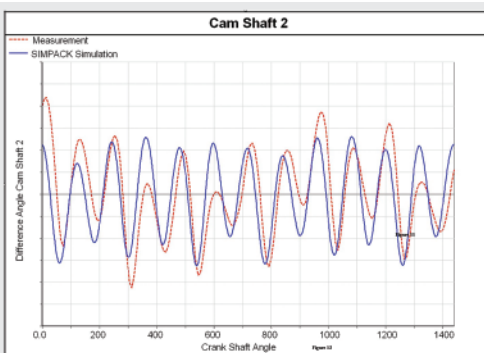


Figure 12

The calculation time required for this model to reach a steady state for a certain rotation speed is in the region of a few hours. The respective chain model on its own is solved in the region of a several minutes to a couple of hours. All the models were calculated on standard single processor PC's. Further calculation time improvements are currently being worked upon at INTEC and tested on this verification model. In the development of the chain module calculation speed is not the only consideration, but a great deal of importance is ensuring that the results are accurate. The very good correlation of the simulation results with the measured data shows how accurate the CHAIN module is. The correlation of the data is shown in the figures 10-12.

# SIMPACK Tips and Tricks - Expressions

**SIMPACK 8.5 introduced the modeling element 'Expressions'. They are a very versatile element which can be used for many different applications.**

Expressions can be seen as functions which process multiple inputs and return them as a single output. The inputs come from measurements which are performed during the simulation, and the Expression returns the result. They can be used to define a force, marker position, time excitation, y-output value or Result Element. They can also be used to return a measurement value. Similar to Substitution Variables it is possible to generate complex formulas using different functions all within one Expression. The difference however is that Expressions are 'dynamic' within the simulation and are recalculated during the integration. Substitution Variables on the other hand are calculated when the simulation is started and then remain constant.

Expressions retrieve their input data from SIMPACK Access Functions, e.g. the function JOINTCF() returns the Joint forces, or FORCEOV() returns the Output Values from a Force Element.

## WHERE CAN EXPRESSIONS BE USED?

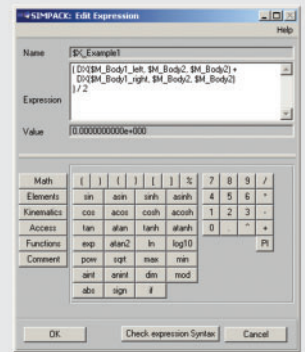
- Force Elements 50 and 51 read-in Expressions and return either a force or moment. Example models are available for both these Force Elements. Force Elements 5 and 43 can also be used with Expressions.
- Time Excitation 12 reads-in one or more Expressions, allowing the motion of a Moved Marker to be easily controlled.
- The Control-Sensor 232 returns the Expression result within a control loop.
- The Y-Output Element 19, which is driven by an Expression, is used within a co-simulation.
- The new modeling element 'Result Element' is used to generate 'General Plots' result data via Expressions and will be available in the next customer release of SIMPACK. See the article on Result Elements.

User Routines can often be replaced with an Expression when either mod-

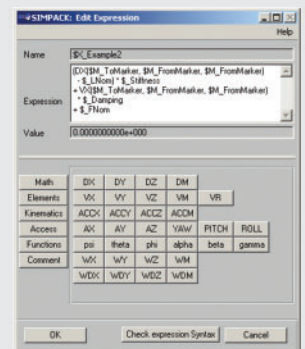
eling Force Elements or Time Excitations. They are even comparable in terms of speed, as they are compiled as a pre-processing step.

## THREE EXAMPLES

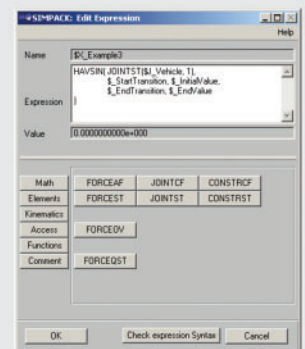
The first example calculates the distance in x between two sets of Markers and returns the mean value: „( DX(\$M\_Body1\_left, \$M\_Body2, \$M\_Body2) + DX(\$M\_Body1\_right, \$M\_Body2, \$M\_Body2) ) / 2“. The calculation is performed from the function DX() which has the same parameters as a Sensor: TO-Marker, FROM-Marker und Reference Marker (see „Tips & Tricks“ from the last SIMPACK News). The second example is a little bit more complicated. The Expression calculates the force from a linear stiffness and damping, whilst also considering a nominal force and length. „(DX(\$M\_ToMarker, \$M\_FromMarker, \$M\_FromMarker) - \$LNom) \* \$Stiffness + VX(\$M\_ToMarker, \$M\_FromMarker, \$M\_FromMarker) \* \$Damping + \$FNom“ (see picture 2). The Force Element parameters come from Substitution Variables. When used with Force Element 51 this Force Element will behave in exactly the same way as Force Element 04 (Spring/Damper PtP)! All good things come in threes. The last example shows a distance dependent excitation with smoothing transitional regions between the initial and final positions. All the parameters are entered as Substitution Variables: „HAVSIN(JOINTST(\$J\_Vehicle, 1), \$StartTransition, \$InitialValue, \$EndTransition, \$EndValue)“ (see picture 3). JOINTST() reads-in a Joint state, for example here the position of a vehicle along the track. HAVSIN() is used to create a smoothed transitional region between the \$InitialValue and \$EndValue. If the Joint state is smaller than \$StartTransition then the Expression returns \$InitialValue. If it is greater than \$EndTransition then \$EndValue will be returned. The returned value will be smoothed in-between \$StartTransition and \$EndTransition, ensuring that no discontinuities occur which could cause problems for the integrator.



Example 1



Example 2



Example 3



*Dino Berki*

#### **HELLO, MY NAME IS DINO BERKI**

I spent my childhood near the Chiemsee lake and moved to Munich where I graduated high school. I then went on to study mechanical engineering at the Munich university of applied sciences.

I graduated in 2001 before starting work at AVL Deutschland GmbH in Munich where I worked as an engineer for automotive projects in the CAE field (CFD, FE and MBS).

In July 2005 I joined the INTEC team to strengthen the projects and sales team. I am currently working on an automotive project, where I already have significant experience. I am also looking forward to working on new projects in the field of wheel/rail and wind turbines.

When I am not working at INTEC then I like to head off into the mountains, in summer on my motorbike and in winter on skis.

#### **HELLO, I AM AXEL DEWES**

I was born and grew up in the town of Erlangen where I also studied technical mathematics, at the University Erlangen-Nürnberg, graduating in February of this year. My studies consisted of three main components, mathematics, computer science and mechanical engineering. The focus of my mathematical studies was optimisation and numerics, in computer studies computer graphics and on the mechanical engineering side I worked a lot with FE and MBS theory. I've been at INTEC since April 2005 which has allowed me to fully utilise what I learned during my studies. I work in the project department at INTEC and am also involved in customer support. I am currently working on a realtime project and also on complex chain simulation projects. Outside of INTEC I like to get involved in a lot of sport and play for a badminton team in Munich. In the winter months I can often be found on the piste. I'm half Finnish and enjoy learning the language as well as travelling to Finland.



*Axel Dewes*

# Latest News in SIMPACK Wheel/Rail

## NEW 2D STICK-SLIP ELEMENT FOR EMERGENCY SPRINGS

The Force Element 195 StickSlip 2D Contact has been available in SIMPACK for a long time. It is a 2D stick-slip friction element which allows lift. The normal force cannot have a nominal force applied due to this lifting. The next SIMPACK release will contain the Force Element 194, which is also used for the modelling of 2D stick-slip friction. This Force Element, however, does not allow lifting and therefore a nominal force can be applied, making it suitable for the simulation of emergency springs in air-springs in railway vehicles. The car-body rests on a sliding plate which is cushioned vertically with an elastomer. The element 194 has a vertical stiffness, damping and nominal force. The 2D stick-slip stiffness behaviour can be controlled in both the longitudinal and lateral directions. It can also be used as a standard friction element, providing lift doesn't occur, e.g. for Lenoir dampers in certain bogies in freight vehicles.

## NEW IN THE TRACK MODULE

SIMPACK's cartographic Track is the easiest way to define a track which consists of straight sections, arcs, clothoids, superelevation and inclines. It is possible to enter the data directly in the GUI or, since 8.709, in the new SIMPACK cartographic track file format (extension .trc). The file format is easy to understand, allows data to be entered efficiently whilst minimising the potential for making mistakes. End radii used for transitional or curve elements can be automatically used as the initial radii for succeeding elements. This makes the copying and moving of track elements a lot easier to perform. The file format allows comments to be added to all of the defined elements, meaning the file is also a good documentation to the track. An example will be prepared in the standard database under „track\_cartographic“. Moreover, in the next SIMPACK release version it will be possible to enter track excitations directly in ASCII format, saving the laborious task of

converting them into binary format. Examples are also available in the directory „track\_excitated“. The binary format will of course still continue to be supported.

## UNTRUE WHEELS

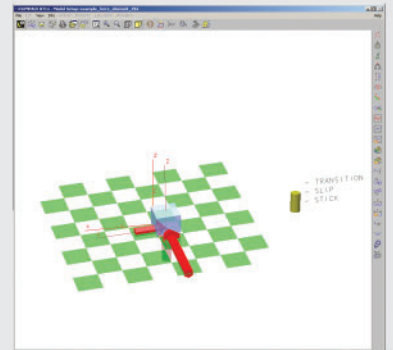
Untrue wheels, contrary to what one would expect, is a situation which often occurs in reality. The definition in SIMPACK has been made a lot simpler with 8.709. The important parameters are set in the Wheel Profile Reference Marker. There are three possibilities:

1. the radial differences can be entered as an input function with respect to the position on the wheel perimeter.
2. through Fourier coefficients.
3. the definition of a simple harmonic function.

The wheel untrueness can be used with any wheelset or independent wheel type (with the exception of wheels on a roller rig). For ensuring that the forces are correctly represented then either the wheelset axle or the entire wheelset should be modelled as a flexible body. The documentation for untrue wheels is found in the documentation for the Moved Marker type 99, Wheel Profile Reference Marker.

## IMPROVED DERAILMENT RECOGNITION

The next SIMPACK release will offer better recognition of wheel-lift and derailed wheels. The user can set the simulation to terminate when a wheel raises more than 5 mm above the rail. The user can also set whether the simulation should be ended even if the wheel is still in contact or only when contact has been lost completely. The first setting represents the wheel climbing up the rail flange, the second when the wheel raises 5 mm off the rail, which can occur in rail twist tests. If this occurs then SIMPACK will return which wheel lifted and will terminate the simulation. This lifting effect is set in the ‚Contact Force‘ window from the ‚Vehicle Globals‘. If this derailment setting is turned on then the constraint contact ‚Wheel Lift‘ recognition should be set to „Set Tx=Ty=0 and continue“.



Stick-Slip Force Element for Emergency Springs

```

STE 50 0 400
CLO 10 0 400      'Entry Clothoid'
CIR 80 0 0        'Circular Arc, re-use end radius of clothoid'
CLO 10 0 0        'Exit Clothoid'
STE 50 0 0        'Station'
BLO 10 0 -200    p=0  'A Bloss ramp does not need a smoothing.'
CIR 80 -200 0    p=2  'But it may have one.'
BLO 10 -200 0    p=3
STE 50 0

CSL 80 0 0
PL2 20 0 30      p=4      ! P_start (re-use end slope of CSL)
CSL 20 0 0
PL2 20 0 0
CSL 60 0 0
PL2 20 0 -20     p=0.5
CSL 30 -20 0     p=0
PL2 20 -20 0
CSL 80 0

CST 50 0
LIR 10 0 0.06    p=0      ! u_start, u_end (in [m])
CPT 80 0.06
LIR 10 0.06 0
CST 50 0 0
BLO 10 0 -0.1   p=0      'Station'
CPT 80 -0.1 0   p=2
BLO 10 -0.1 0   p=3
CPT 50 0

```

Cartographic Track File in SIMPACK Format

## Latest News



Land Rover Discovery

### CONGRATULATIONS LAND ROVER

Our congratulations goes out to the Land Rover team for their work on the double award winning Discovery. A very impressive presentation, "Uses of SIMPACK on the All New Land Rover Discovery", may be downloaded from [www.simpack.com](http://www.simpack.com) under software, publications, User Meeting 2004.

### PLOT SUBVARS AND FORMULAS IN THE NEW SIMPACK PLOT

Substitution Variables (SubVars) and Formulas can now be used to define filter parameters in the new plot module. The SubVars are part of the loaded sbr file and are listed in the result tree. They can be assigned to a filter parameter by simply dragging and dropping them from the result tree onto a filter parameter. In addition to SubVars, in place formulas can now be used when defining filter parameters. E.g.  $\text{par}(2) = \sin(\text{PI}/2) * 4711$  A formula must be well formed QSA script code that returns a double value. Formulas can contain substitution variables (e.g.  $\text{sin}(\text{resf1.subvar\_sv1} * 10)$ ).

Please note that the leading „\$“ sign of the SubVar name must be omitted and that to properly reference the right SubVar from the right result file, the SubVar name must be prepended by the result file index, e.g.  $\text{resf1.subvar\_sv1}$ !

### NEW SIMPACK PLOT FEATURES ANNOTATIONS

Annotations have been added to the new plot module.

Annotations are text frames that can be placed and moved inside a diagram. They are very useful for marking specific areas of interest inside a diagram, such as the maximum of a curve, or the impact on a curve of a specific event.

Annotations can be either free, attached to a curve or attached to a specific coordinate. In the latter two cases a line or an arrow is drawn from the annotation to the selected coordinate or curve point.

Annotations can also contain „Live Text“ e.g. for displaying current curve x- and y-values.

### 19. IAVSD SYMPOSIUM ‚DYNAMICS OF VEHICLES ON ROADS AND TRACKS‘

The week long 19th IAVSD Symposium 'Dynamics of Vehicles on Roads and Tracks' in Milan (in the end of August 2005) gave a good insight into the ongoing developments in the field of system dynamics for railway as well as automotive vehicles. INTEC was present, not only just to keep up with the latest developments, but was one of the event sponsors and exhibitors.

### RESULT ELEMENT

'Result Elements' have been added to SIMPACK. This new element type enables the user to define custom result requests, e.g. grouping the contact forces of all tyres of a vehicle into a single element. Each result element can have an arbitrary number of output channels. Result Elements can be logically grouped in a tree structure as well as switched on or off. They can be defined in main models or substructures. User specific Result Element types can be created via SIMPACK User routines.

When performing the measurement run, the user can specify, if all standard SIMPACK measurements should be computed or if only measurements for the result elements should be generated. This can greatly reduce the amount of data generated during a measurement run.

### TMEASY

The tyre model TMeasy is now available as a new SIMPACK module. TMeasy is an easy to use tyre model designed specifically for efficient standard driving dynamic simulations and for finding a vehicle's handling limits. It's easy to fit measured tyre characteristic data with the tyre model parameters due to their intuitive meaning. This tyre model therefore also allows the user to easily adapt the model property characteristics to their needs. Please contact INTEC if you would like to receive more detailed information on the new module TMeasy within SIMPACK.



IAVSD Symposium in Milan

### MODAL STRESS/STRAIN CALCULATION WITHIN SIMPACK

The new version of LOADS Durability is able to read the input data of FEM-FAT MAX in order to perform modal stress or strain calculations in SIMPACK. Currently, the user can define several virtual strain gauges on the structure. The results can be displayed in SIMPACK's new plot tool. The results obtained in SIMPACK have been compared with transient analyses in ANSYS and the results were consistent for static and dynamic loading. Of course, local effects within nodes can precisely be calculated with the modal stresses as implemented in SIMPACK. The advantage of the coupled finite element and multibody system analyses, when compared with a transient finite element analysis, is the calculation speed, which allows us to calculate stress and strain for long simulation periods whilst using finite element and multibody system models with any level of detail. (Figure 1 and 2)

### GRAPHICAL REPRESENTATION OF FLEXIBLE BODIES

By default SIMPACK's model set-up and postprocessor can picture meshes of finite element models if their source is ANSYS, NASTRAN, IDEAS or PERMAS. With SIMPACK's new interface to ABAQUS the user can now also import ABAQUS input files to generate a graphical representation of flexible bodies. Based on the nodes and elements of the ABAQUS model FEMBS generates a CAD-representation of the mesh, which is to be integrated into the SIMPACK model as a graphic primitive. To obtain the CAD-wavefront file, select the ABAQUS input file in addition to the result files, which are obtained after the reduction and the modal analysis of the reduced ABAQUS model.

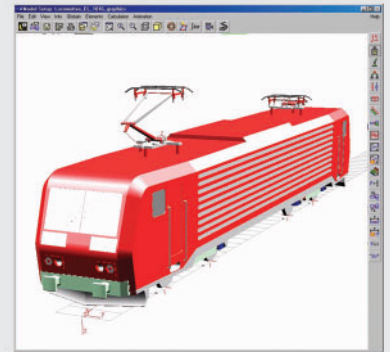


Figure 1: SIMPACK Model of a Locomotive

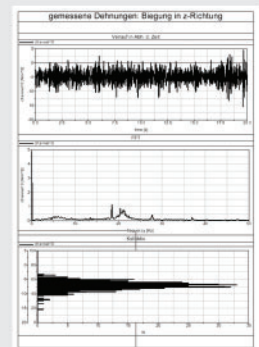


Figure 2: Time History of Strain of a Part, which is attached to the Bogie Frame



## SIMPACK TRAINING COURSES

November 2005	07.11. – 08.11.2005	SIMPACK BASIC Training
	09.11. – 10.11.2005	SIMPACK Wheel/Rail Training
	09.11.2005	SIMPACK Automotive+ Training
	11.11.2005	SIMPACK Rail Switches Training
December 2005	05.12. – 06.12.2005	SIMPACK BASIC Training
	07.12.2005	SIMPACK User Routines Training
	08.12.2005	SIMPACK NVH Training
January 2006	16.01. - 18.01.2006	SIMPACK BASIC Training
	19.01. - 20.01.2006	SIMPACK Wheel/Rail Training
	19.01.2006	SIMPACK Automotive+ Training
	24.01.2006	SIMPACK Code Export Training
	25.01.2006	Simulink Interfaces Training
February 2006	13.02. - 15.02.2006	SIMPACK BASIC Training
	16.02. - 17.02.2006	SIMPACK Wheel/Rail Training
	16.02.2006	SIMPACK Automotive+ Training

## SIMPACK ACADEMY

26.01. - 27.01.2006 Railway Vehicle System Dynamics

## SIMPACK AT CONFERENCES AND EXHIBITIONS

01.12. - 02.12.2005 Dresdner Maschinenelemente Kolloquium DMK 2005, Dresden, Germany

21.03. - 22.03.2006 SIMPACK User Meeting in Baden-Baden, Germany

09.05. - 11.05.2006 Vehicle Dynamic Expo 2006, Stuttgart, Germany



*We would be glad to welcome you to our SIMPACK training courses or to a SIMPACK Academy course. To register for one of this courses or to discuss your training requirements please contact*

*Erni Sabine Engert by e-mail:  
 erni.engert@simpack.de  
 or by telephone:  
 0049 8153 9288-40  
 or by fax:  
 0049 8153 9288-11*

*Ms Engert looks forward to hearing from you.*

## CONTACT

### » CHINA

ESP  
Intelli-Center B Room 1709  
Zhongguancun East Road No.18  
Haidian District, Beijing 100083  
P.R. China  
Tel.: +86 - 10 - 826 015 56  
www.bj-esp.com

### » FRANCE

Francois Barral Consulting  
9, Rue Elie Rochette  
69007 Lyon  
Tel.: +33 - 478 724 551  
Mobil: +33 - 673 889 65

### » GREAT BRITAIN

INTEC Dynamics Ltd.  
Cambridge Road Industrial Estate  
Whetstone, Leicester LE8 6LH, UK  
Tel.: +44 116 275 1313  
Fax: +44 116 275 1333  
info@intecdynamics.co.uk  
www.simpack.com

### » JAPAN

Altair Engineering, Ltd  
25F Sunshine 60, 3-1-1 Higashi-Ikebukuro,  
Toshima-ku, Tokyo 170-6025, Japan  
Tel.: +81 - 3 - 5396 - 1341  
Fax: +81 - 3 - 5396 - 1851  
www.altairjp.co.jp

### » WORLDWIDE

INTEC GmbH (Headquarters)  
Argelsrieder Feld 13  
82234 Wessling  
Tel.: +49 - 8153 - 9288 - 0  
Fax: +49 - 8153 - 9288 - 11  
www.simpack.com

## PLEASE SIGN ME UP FOR THE FREE DELIVERY OF THE SIMPACK»NEWS (copy, fill in, fax to +49-8153-9288-11)

Name	<input type="text"/>
First Name	<input type="text"/>
Firm	<input type="text"/>
Street	<input type="text"/>
Post Code	<input type="text"/>
Location	<input type="text"/>
Country	<input type="text"/>
Telephone	<input type="text"/>
Fax	<input type="text"/>
E-Mail	<input type="text"/>

## I WOULD BE INTERESTED IN THE FOLLOWING APPLICATIONS

<input type="checkbox"/> Automotive	<input type="checkbox"/> Aerospace	<input type="checkbox"/> Real-Time
<input type="checkbox"/> Engine	<input type="checkbox"/> General Machinery	<input type="checkbox"/> Drive Train
<input type="checkbox"/> Wheel/Rail	<input type="checkbox"/> other _____	

## SIMPACK»NEWS

1996 – 2005

Circulation: 3500  
SIMPACT Version 5, 6, 7, 8, 8.5, 8.6, 8.7  
FEMBS, Loads, ProSIM, CatSIM,  
IdeSIM, MATSIM, SIMAT  
(INTEC GmbH)

Registered Trademarks

ABAQUS:  
Abaqus, Inc

ANSYS:  
Swanson Analysis Systems, Inc.

CATIA:  
Dassault Systemès

MATLAB:  
The MathWorks, Inc.

MSC.MARC:  
MSC.Software Corporation

MSC.NASTRAN:  
MSC.Software Corporation

Pro/ENGINEER:  
Parametric Technology Corporation

