

SIMPACK Code Export

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Code Export & Simulink Interfaces

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What Are You
Intending To Do?

SIMPACK Code Export



What Are You
Intending To Do?

Agenda

- ? What is Code Export ?
- ? Functionality
- ? Fields of Application
- ? Example
- ? Outview

SIMPACK Code Export

Generating equations of motion



What is Code Export ?

Functionality

Fields of Applications

Example

Outview



Internally: equations are not visible for user

- + easy model access for GUI - pre-/post processor, solver
- + various analysing tools available
(linear system analysis, kinematics, equilibrium calc)
- + no compile or link necessary
- dependent on software installation
- difficult to integrate to other systems
- higher calculation time
- > model verification, analysing subsystems → offline simulation



Externally: equations are written to file in programming language

- + direct access to equations for user
- + easy to integrate into other systems
- + reduced calculation time
- external pre-/postprocessor necessary
- costly model modification
- > integration of verified subsystems in global simulation → online simulation



SIMPACK combines both possibilities of processing equations of mechanical systems and with that offers a unique process patency

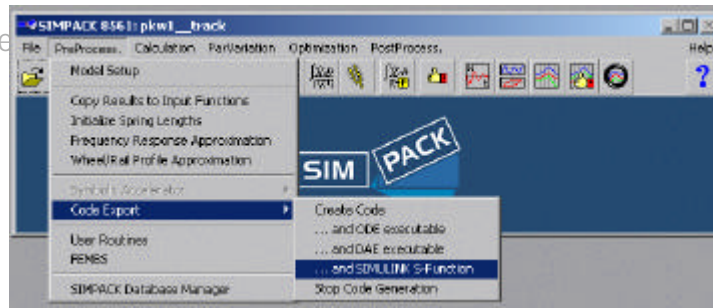


What Are You
Intending To Do?

SIMPACK Code Export

Code Generation

- ▶ What is Code Export ?
- Functionality
- Fields of Applications
- Example
- Outview



What Are You Intending To Do?

```

SIMPACK Echo Area: Build Symbolic Code
test
for EXPLICIT DAE
** Generate code for MBS data
** Generate code for general RHS
** Generate code for general Y-Vector
** Generate code for ODE-Interface
** Generate code for MBS-Element parameters
** CPU-time for generating code: = 9.0999998E-02 [sec]

*****
* Backward-Code-Optimization: remove unused statements *
*****

** File =
symbolic_code_Rhs.f

** File =
symbolic_code_Y.f

** End of backward-optimization

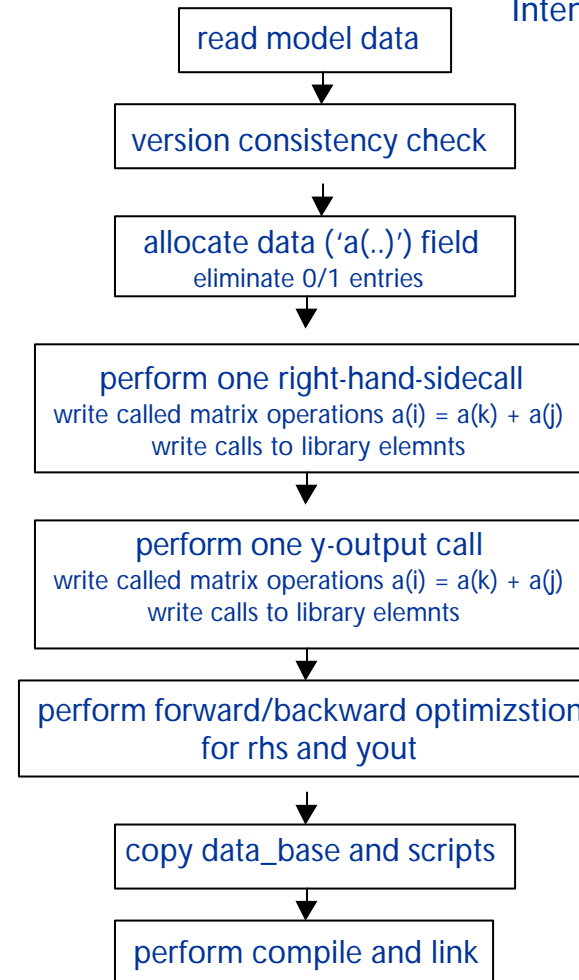
*****
*** Forward-Optimization of symbolic Code ***
*****

** File =
symbolic_code_Rhs.f.opt
- optlev = 0: split in subroutines

** File =
symbolic_code_Y.f.opt
- optlev = 0: split in subroutines

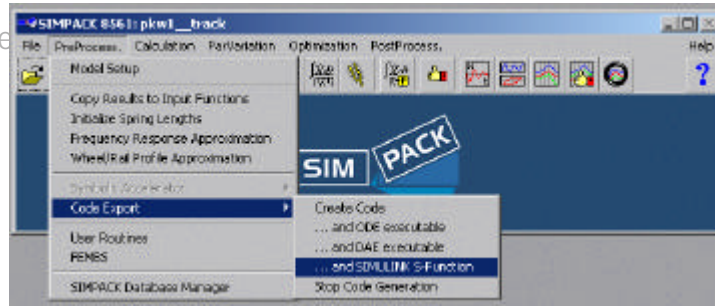
** End of code-forward-optimization

** Code-Optimization Statistics:
-----
for file: symbolic_code_Rhs.f.opt
number of removed lines = 362
number of codestaments = 76
number of subroutines = 1
for file: symbolic_code_Sen_Pos.f.opt
number of removed lines = 0
number of codestaments = 0
number of subroutines = 0
for file: symbolic_code_Y.f.opt
number of removed lines = 1
number of codestaments = 57
number of subroutines = 1
    
```



SIMPACK Code Export

Code Generation



What Are You Intending To Do?

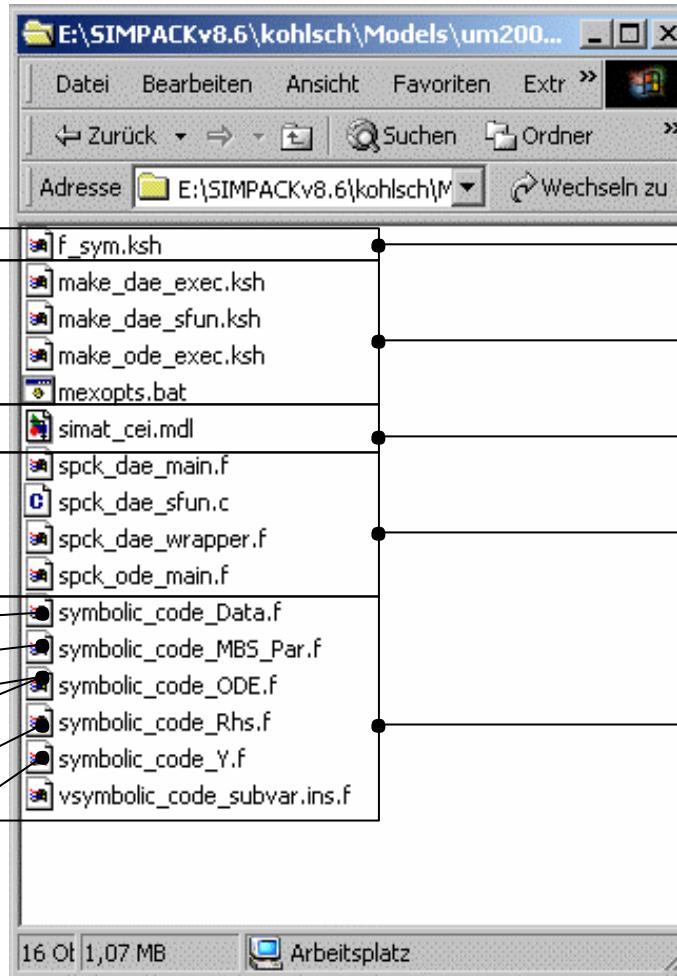
What is Code Export ?

Functionality

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Outview



new created directory:
 <model>.sym

[Examples for compile link & solver couplings](#)

platform-independent F90 compile script

application specific link scripts

default SIMULINK model

application specific frame routines

[model specific symbolic code](#)

m, I_{ij}, com

$P(i)$

$x(t=0)$

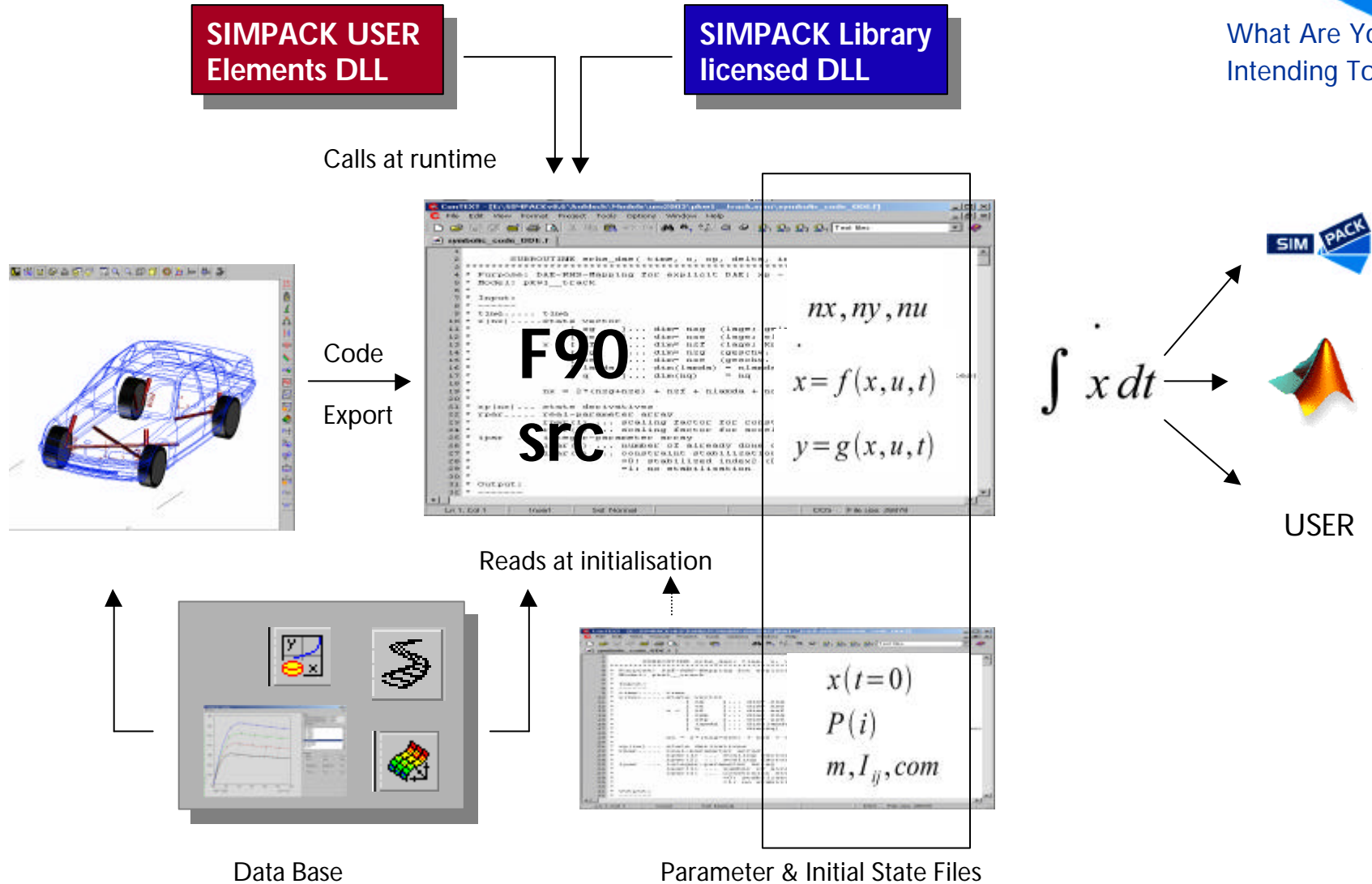
nx, nv, nu

$x = f(x, u, t)$

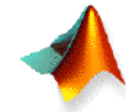
$y = g(x, u, t)$

SIMPACK Code Export

Code Execution



What Are You Intending To Do?



USER



What Are You
Intending To Do?

SIMPACK Code Export

What is Code Export ?



Functionality

Fields of Applications

Example

Outview

Code Export functionality was originally designed to handle time intensive applications like Parameter Variations and Optimisations

▶ SIMPACK Symbolic Code (ceased with v8.0)

▶ SIMPACK Code Export

- replaces external Symbolic Code to be used with arbitrary solver systems
- offered in several stages of functionality range
- functionality will be expanded according to customer needs
- Stage 0 available since 11/2002 with v8.5
- Stage 1 first minor release available since 04/2003 with v8.6

▶ SIMPACK Symbolic Accelerator (not yet available)

- replaces internal Symbolic Code for time intensive applications



What Are You
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SIMPACK Code Export

Code Export Stages

What is Code Export ?

Code Export will be offered in different stages



Functionality

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Stage 0: functionality of v8.0 Symbolic Code

- + standard SIMPACK elements supported
- + static parameters
- + locally defined Input Functions
- + ...



Stage 1: expanded Stage 0 functionality according to customer requests

- + Automotive+ Elements (Tyre 49, Track Joint, ...)
- + Functions from Data Base (Input Functions, IPF Arrays, Track)
- + dynamic parametrisation (elements, rigid body data, initial state)
- + elastic bodies
- + array base description of axis (elasto) kinematics
- + DAE-free macro-description of axis (elasto) kinematics
- + ...
- Wheel Rail
- Contact
- Root Functions



What Are You
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SIMPACK Code Export

Special functionality Stage 1

What is Code Export ?

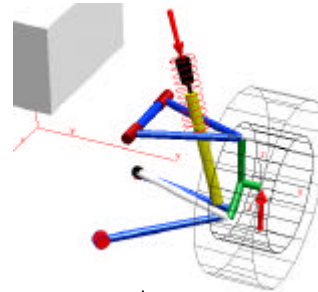


Functionality

Fields of Applications

Example

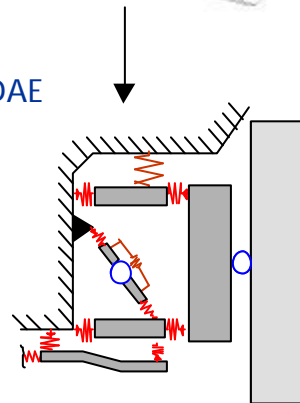
Outview



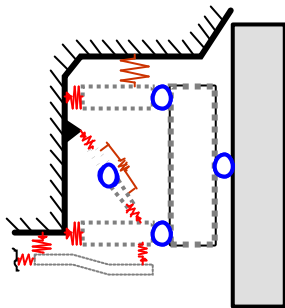
Physical wheel
(elasto) kinematic

*)

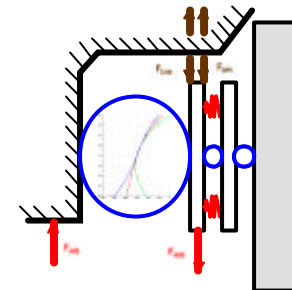
Conventional
SIMPACK ODE/DAE
Model



DAE – free Macro joint
for (elasto) kinematics



DAE – free
(elasto) kinematics
using pre-calculated
arrays



SIMPACK Code Export

Licensing

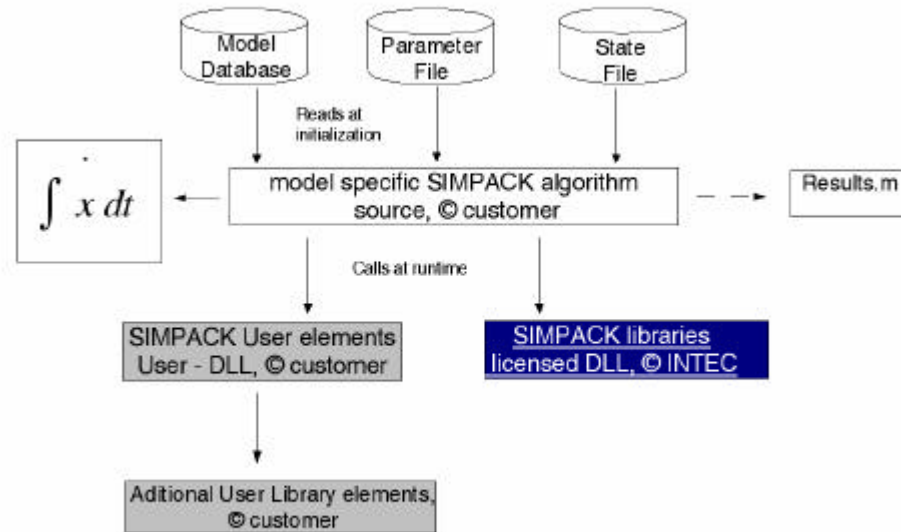
What is Code Export ?

Functionality

Fields of Applications

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Outview



- ▶ Model specific exported code is customer's property
- ▶ Code Generation: generation of code depending on stage level
- ▶ Code Execution: Usage of SIMPACK element library depending on stage level
- ▶ Source Code of Element Library: available within special agreement
- ▶ Solver: may be used with solver license



What Are You Intending To Do?



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SIMPACK Code Export

Advantages of model based on exported Code

What is Code Export ?

Functionality



Fields of Application

Example

Outview

- ▶ Independent from any SIMPACK installation
- ▶ For execution no SIMPACK modelling/user experience is necessary
- ▶ Expandable to user needs, e.g Post Processing
- ▶ Reduced calculation time according to code optimisation
- ▶ No modelling know how is disclosed when model is handed on
- ▶ Code can be linked to arbitrary solvers:
 - User specific
 - external SIMPACK Solvers
 - comercial Solver systems, e.g. MATLAB
- ▶ Several options of coupling and communication to solver system are possible:
 - static or dynamic linking
 - function call or co-simulation
 - one or two process communication (socket, shared memory)
- ▶ Integrated modeling in offline (SIMPACK) and online (exported code) simulation

SIMPACK Code Export



Environment
Cartographic Road Track
Road Surface



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What is Code Export ?

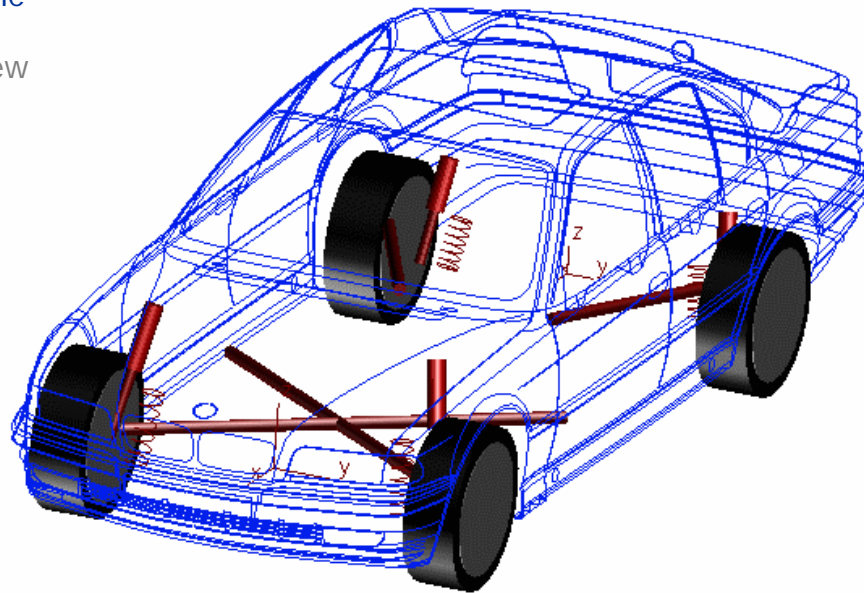
Functionality

Fields of Application



Example

Outview



Joints
19: Automotive Track Joint
...



Constraints
28: Massless Link



Force Elements
49: Automotive Tyre
Pacejka Similarity
...



Control Elements
168: Automotive Track Sensor



Input Function Set
Suspension Stiffness



Input Function Array
Tyre Friction Coefficient



SIMPACK Code Export



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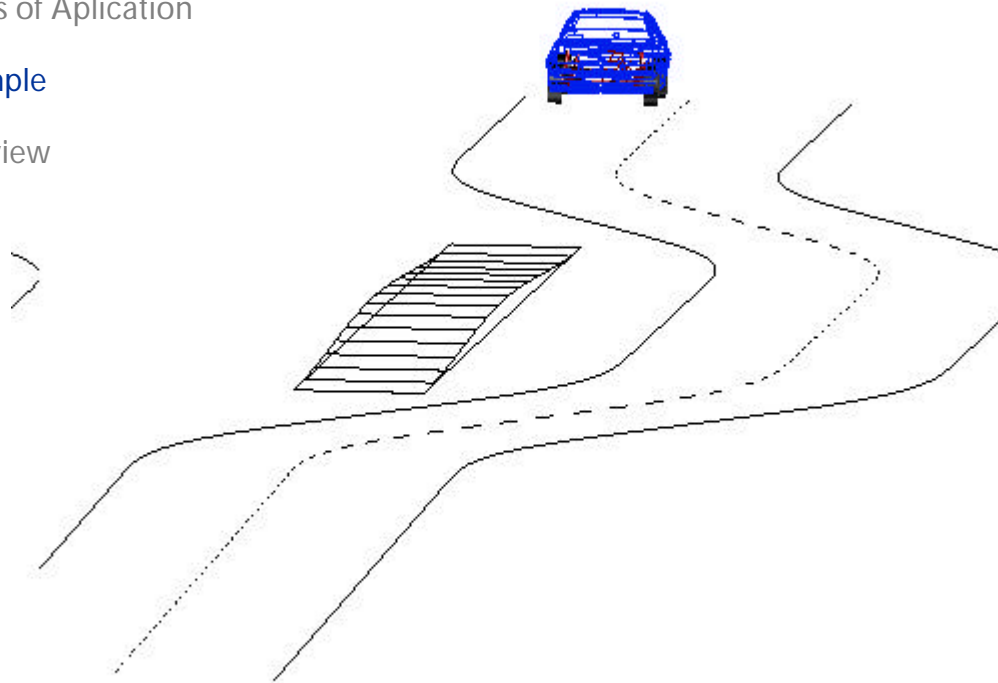
What is Code Export ?

Functionality

Fields of Application

▶ Example

Outview



Joints
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Control Elements
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Input Function Set
Suspension Stiffness



Input Function Array
Tyre Friction Coefficient

SIMPACK Code Export

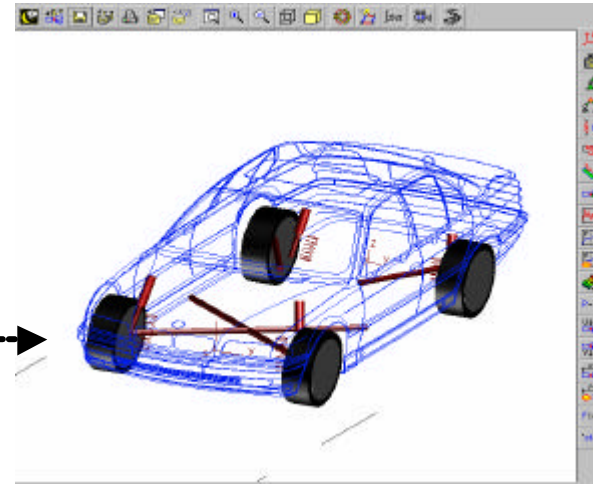
What is Code Export ?

Functionality

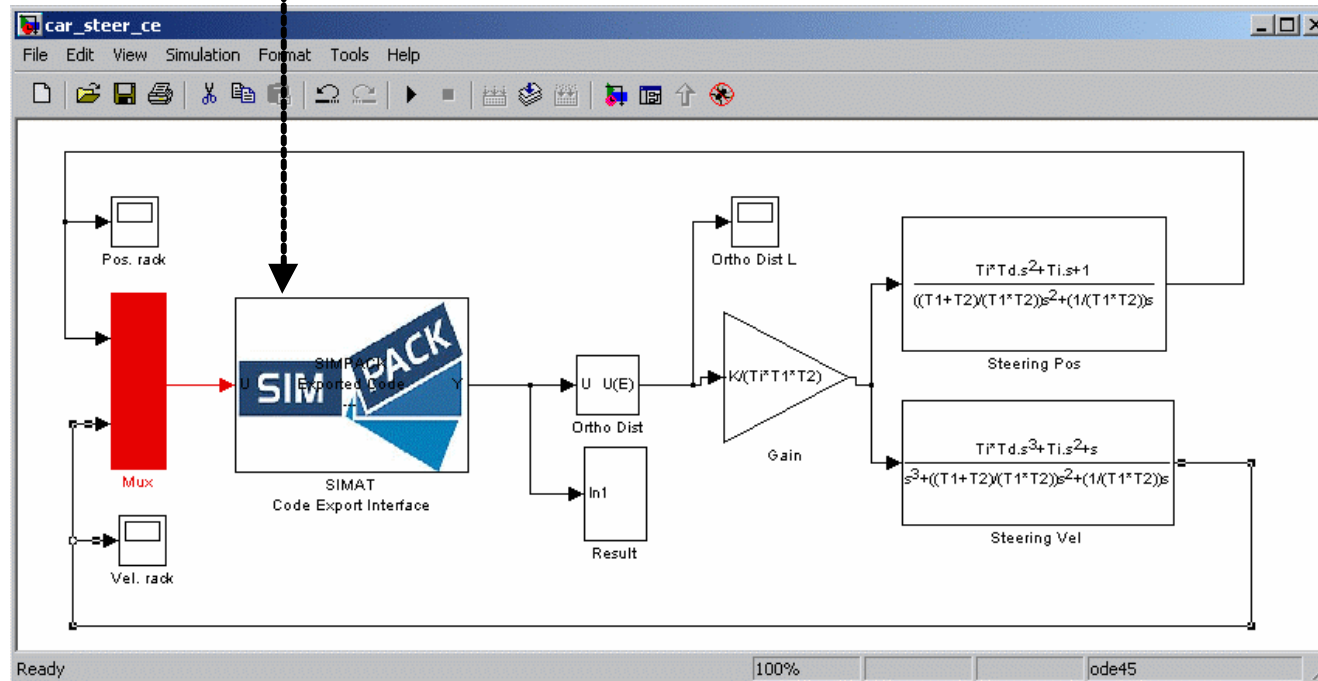
Fields of Application

▶ Example

Outview



MATLAB Steering control sensor using SIMPACK
Automotive track sensor in exported code



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SIMPACK Code Export



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What is Code Export ?

Functionality

Fields of Application

Example

▶ Overview

Outview

- ▶ Supported Platforms
 - > by now: Windows, HP UX, Silicon Graphics
 - > soon: IBM, SUN;
 - > possible Linux/ i386
- ▶ Code Export is offered in several stages of functionality.
Stage 1 shipped in minor releases
- ▶ Source Code available within special agreements
- ▶ Options for Hardware in the Loop Platforms:, still to be investigated
 - > Linux based HIL platforms now supported
 - > re-build to f77 -> f2c -> f90
 - > creating f90 objects/binaries on target platform
 - * which CPU/OS combinations ?
 - * binary compatibility ?

