The Easy-to-use Steering Design Tool "SimuLENK" as an Application of SIMPACK Code Export
Contents

- Inspiration for development of a new kind of software
- Vehicle configurations and steering kinematics of trucks and buses
- Concept and architecture of SimuLENK
- SIMPACK models used as basis
- SimuLENK User Interface
- Advantages of the concept
- Further development
Inspiration


- Our idea: Possible usage of SIMPACK Code Export not only for real time applications but also for „easy to use“ simulations for everybody.

- Exported SIMPACK code can replace a lot of handwritten routines for solving mechanical problems.

- Many use cases!
  Example: Design of steering systems for trucks and buses.
Prototype of a Code Export Software Selection of Topic “Steering Systems”

- **Benefit:** Design of steering systems requires a lot of engineering capacity in development and could be accelerated
- **Status:** Historically grown but heterogeneous compound of different software products for steering design (Fortran, SIMPACK, CATIA Kinematics, MS Excel,...)
- **Problem:** Complex variety of different vehicle configurations of trucks and buses!
Vehicle and Axle Configurations of Trucks and Buses

- About 15 basically different axle configurations in series
- Different wheelbases, chassis heights and suspension types for every configuration
- Leading and trailing axles can be non-steered or steered positively or by adhesion
- Every vehicle has to comply with homologation specifications like max. clearance radius (12.5 m) or max. rear end swing-out on leaving bus-stop.
Steering Kinematics of Trucks and Buses

Two truck front axles with multipart steering rods

Rigid front axles of a truck

Independent front suspension of a coach with three-part steering rod
Concept of SimuLENK

- “SimuLENK“ = composition of „Simulation“ + „Lenkung“ (German: Steering)
- Different modes of simulation
  - Steering trapeze
  - Clearance circle
  - Steering linkage
  - and more...
- Dynamic handling of user interface appearance, parameter input and results output depending on selected simulation mode
- Input data and results stored in the same Excel file
- Data conversion handled by Excel internal functions and VBA code
- Input parameters are exportable to fully consistent SIMPACK models
- Embedded in MAN server network
- Only frequently asked simulation cases to be considered
- **Easy to use!**
- **Available for everyone in company!**
Architecture of SimuLENK

SimuLENK
Excel User Interface
Input parameters + results stored in the same *.xls-file

Parameter Set

VBA Socket

Exported MBS Code
Model_DAE.exe

Result file
ASCII, temporary

SIMPACK Model

Result file
SIMPACK SBR

SimuLENK environment

Code creation (1x)

Compatible results

SIMPACK environment for SIMPACK professionals
SIMPACK Model Structure

Several main models based on common substructures.

Different model extension stages depending on simulation mode:
- Axle with steering trapeze only
- Axle(s) with steering trapeze(s), rods and (partially) gear
- Full vehicle with steering trapeze(s)
- Full vehicle with steering trapeze(s), rods and (partially) gear

simple & fast

complex & slow
Presently available:
- 6 different axles (steering, trailing, rear axles)
- Complete steering linkage for every front axle configuration and combination
- Chassis
SIMPACK Main Models

- Universal main model including all possible axle types
- Axles not in use are lifted and get zero load
- TMeasy tyre model with different tyre parameter sets
- One or two driven rear axles (no AWD in actual stage)
Parameterization and Results Handling

- One common set of presently 130 parameters
- Results matrix with nearly 50 output vectors
- Custom-made user routines for analysis of important values, e.g. projected rod angles, clearance circles or path radii
- All results have to be directly accessible as SIMPACK output - avoidance of external conversions by Excel!

![Graphs showing the relationship between Winkel Rad am Boden Links and Wendekreisradius for SimuLENK and SIMPACK.](image-url)
SimuLENK Excel User Interface

Input Sheets

- Number of necessary input sheets depends on simulation mode
- Logical checks of user inputs
- Parameter sets like axle and tyre data available from server stored databases
- Alternative possibilities of data input, e.g. in cartesian or cylindrical coordinate system
- Drawings for facilitation of parameter input
- Immediate feedback of simple results (e.g. length of tie rods) permits parameter checks in CAD
- Data input in CAD coordinate system and in usual units like [mm] or [°]
SimuLENK Excel User Interface
Solver Run
SimuLENK Excel User Interface

Results

- Comprehensive report with summary of
  - model description
  - input parameters
  - diagrams
  - numerical results

- Additional results table for detailed information about discrete values
Advantages of the Simulation Process shown

- Comprehensive description of necessary input parameters
- Preprocessing with comfortable possibilities of parameter conversion
- Familiar environment (MS Office) for most of users
- Gentle introduction of non-simulation engineers to simulation methods
- No SIMPACK installation on desktop clients required
- Independence of SIMPACK releases („frozen” state)
- Simulation via SimuLENK Excel interface uses identical parameters and produces same results as SIMPACK internal simulations
  => possibility of advanced calculations in simulation department
Further Development

- Subsequent projects with the following contents
  - Consideration of trailers, semi-trailers and articulated buses
  - Rear end swing-out on leaving bus-stop
  - Steering effort
  - Elastokinematics
  - Modelling of steering gear and steering column
  - Deviations on jounce and braking
  - Assembly of driven steering axles
- Enhanced versions and quality management
- Batch calculations, possibly with optimization algorithms
- **Transfer of SimuLENK idea to other use cases...**
Thank you!