



Innovations in Vehicle Simulation Software for Ease of Use

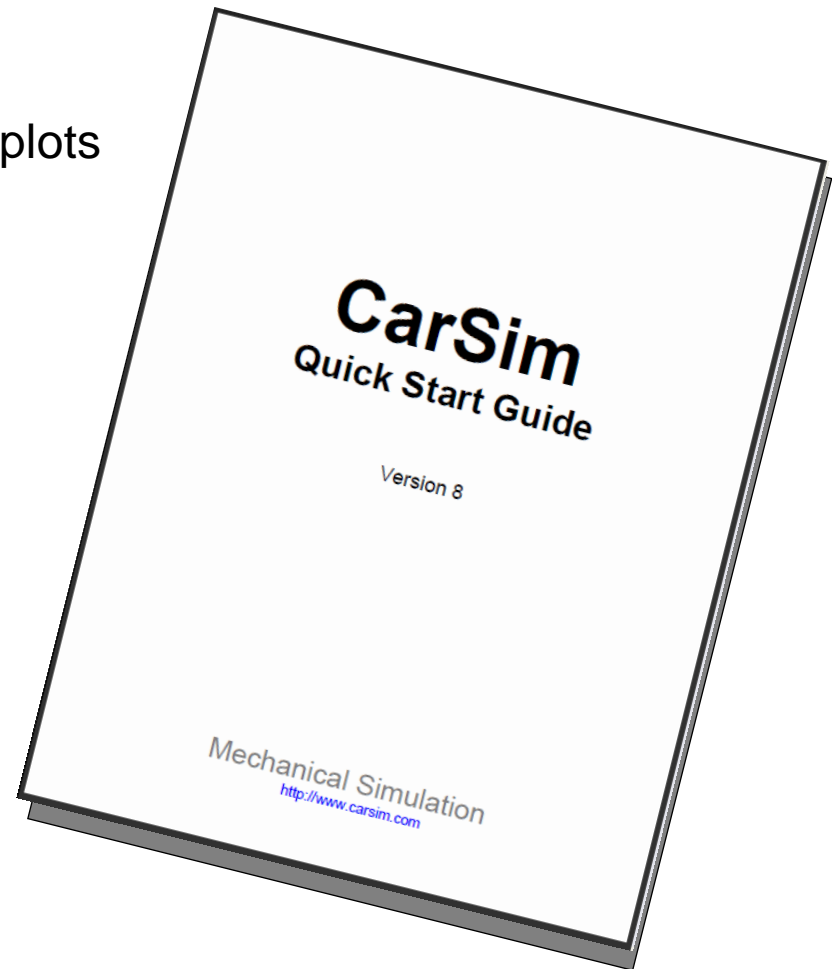
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Background

- Applications for vehicle dynamics simulation tools in the automotive industry are constantly expanding
- To meet the needs of new users the software must grow in features, sophistication and complexity
- The challenge to software designers is to keep the software easy to use despite increasing complexity
 - Keeping the interface intuitive (obvious)
 - Structuring the interface for ease of use (efficient)
 - Making it easy to set up vehicles and tests
 - Facilitating evaluation of results
 - “Help” resources
- CarSim 8 has many features illustrating these techniques

Quick Start Guide

- Learn to use software in 2-hour exercise
 - Run control
 - Animating simulation results
 - Plotting results and creating new plots
 - Creating databases
 - New test procedures
 - Changing vehicle properties
 - Desktop shortcuts
 - Managing multiple databases



Program Structure

- Keeping it simple and consistent

The screenshot shows the CarSim Run Control software interface. The window title is "CarSim Run Control; { Animator Features } Camera Tracki...". The menu bar includes "File", "Edit", "Datasets", "Libraries", "Tools", "View", and "Help". The toolbar contains icons for navigation (Back, Forward, Home, Previous, Next), file operations (New, Save, Undo, Redo, Lib Tool, Parsfile), and other functions (Delete, Sidebar, Refresh, Help, Lock). The main interface is divided into three columns:

- Vehicle & Procedure:** Includes dropdowns for "Vehicle configuration: Ind_Ind" (B-Class, Sports Car) and "Procedure" (Leading Car on Road Course). A checkbox "Show more options on this screen" is present.
- Run Control: Built-In Solvers:** Features a "Run Math Model" button, a "Models" dropdown, a checkbox "Write all available outputs", and an "Output variables:" dropdown.
- Results (Post Processing):** Includes an "Animate" button, a "Set run color" checkbox (yellow), a "Tracking Camera Centered" dropdown, a "Plot" button, and a "Show more plots:" dropdown (0).

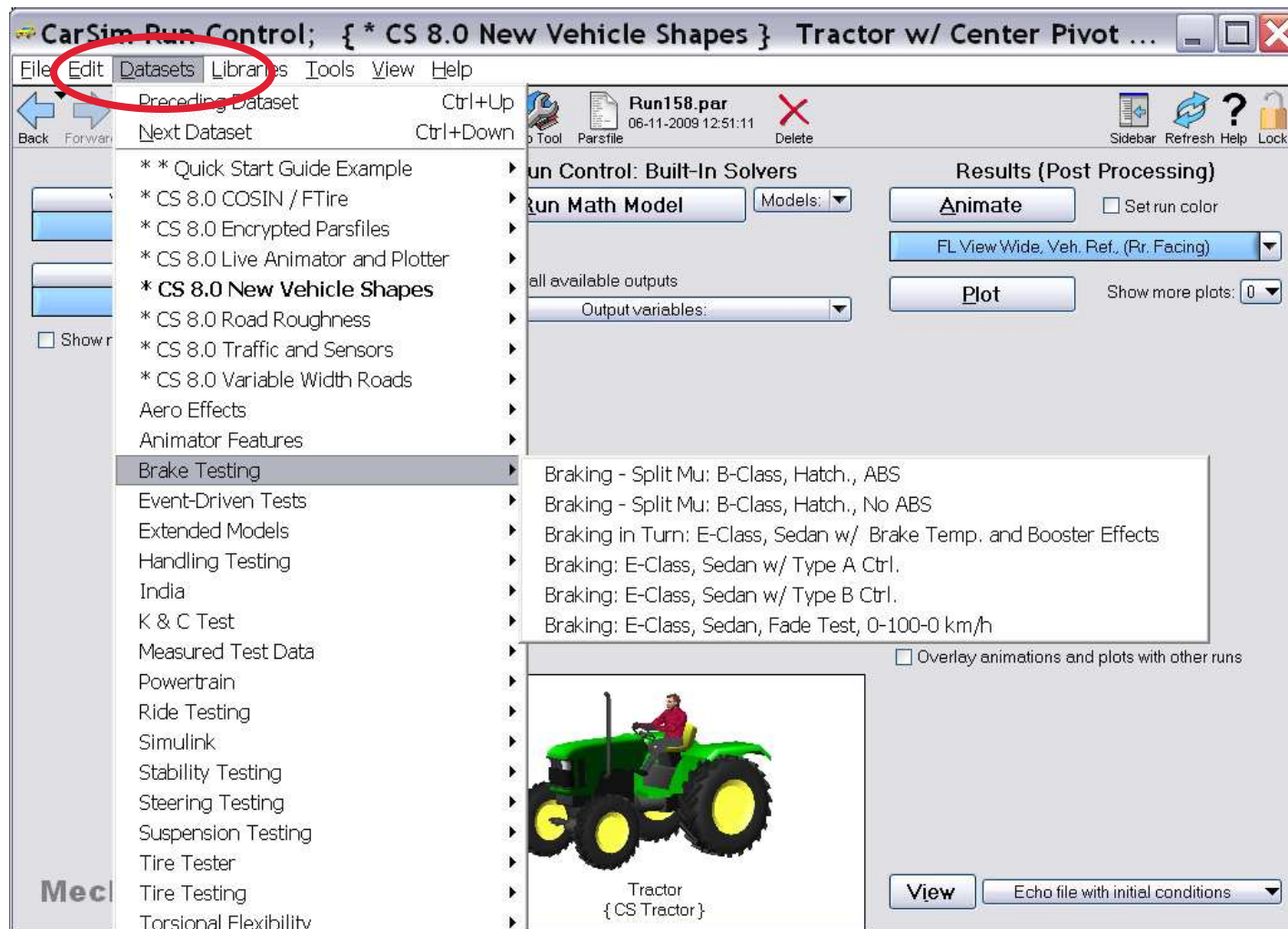
Red brackets group these sections into three main steps:

- Set up the vehicle and test maneuver:** Points to the Vehicle & Procedure section.
- Make the Run:** Points to the Run Control: Built-In Solvers section.
- Animate and plot results:** Points to the Results (Post Processing) section.

At the bottom left, the CarSim logo and "Mechanical Simulation" text are displayed. A red box labeled "Car being simulated" has an arrow pointing to a 3D rendering of a blue sports car. Below the rendering, the text "B-Class, Sports Car { CS B-Class }" is shown. A "View" button and a dropdown menu "Echo file with initial conditions" are located at the bottom right. A checkbox "Overlay animations and plots with other runs" is also present.

CarSim Example Tests

- Over 100 examples give users a starting point for setting up their first simulation



The Car*Sim* Vehicle Family

- Start simulating immediately – choose from data sets for 26 generic vehicles



A-class
Hatchback



B-class
Hatchback,
Sports car



C-class
Hatchback



D-class
Minivan,
Sedan, SUV



E-class
Sedan, SUV



F-class
Sedan



F3



GT



Pickup



Mini Truck



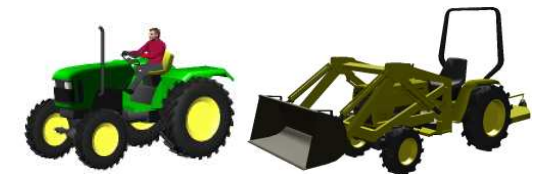
3-Wheeler



Euro Van



Trailers

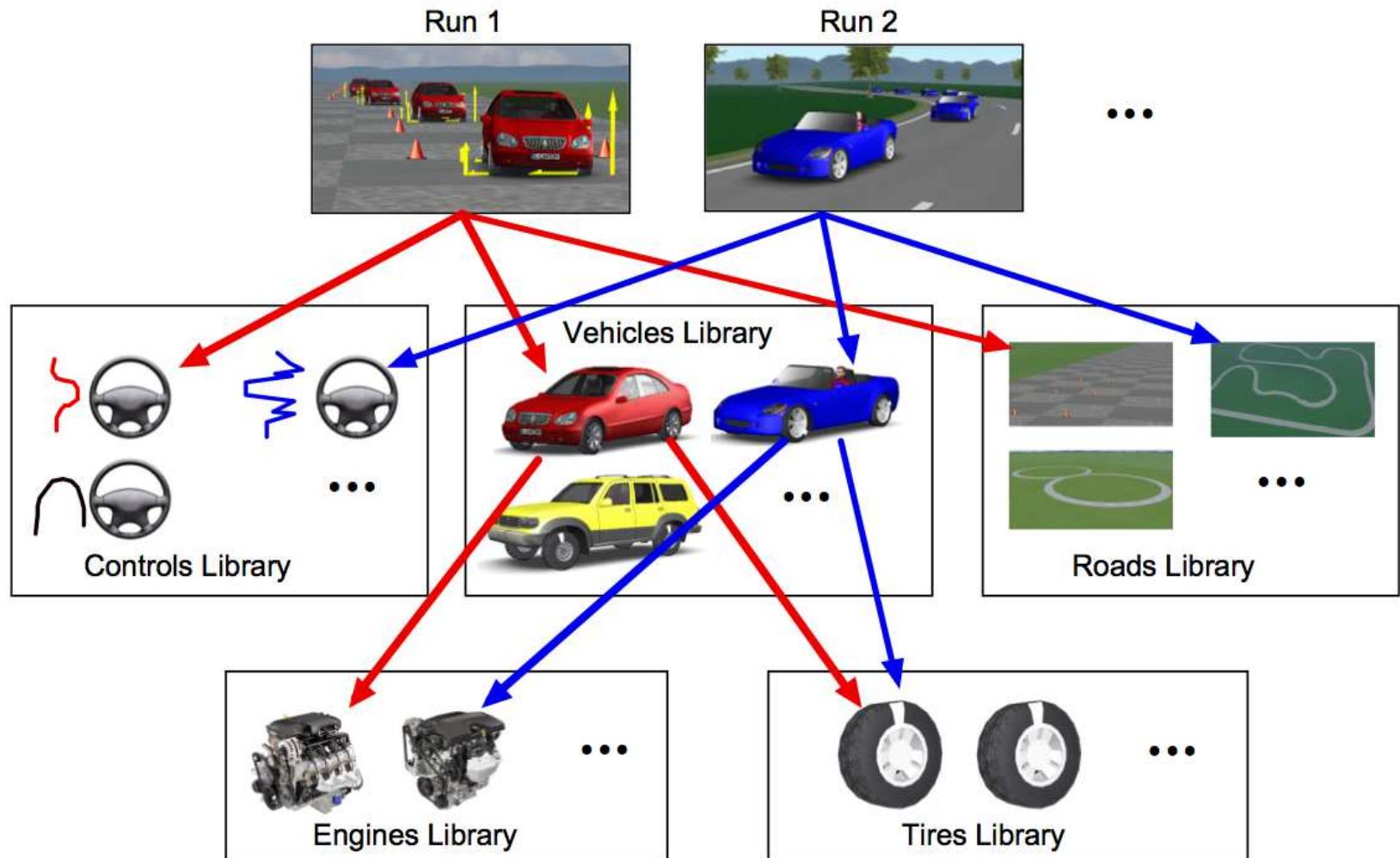


Tractors



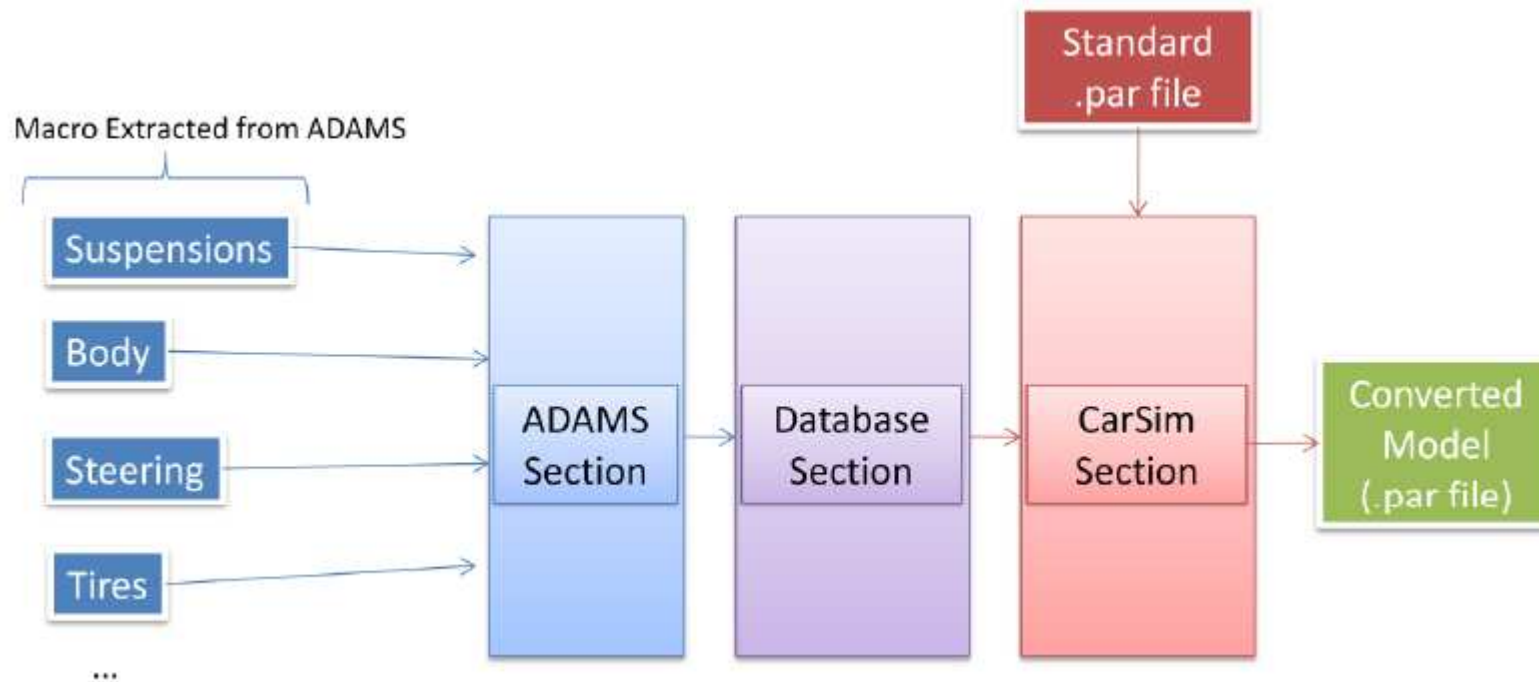
CarSim Database Structure

- Simulation datasets are “assembled”
- 160+ libraries (screens)



Connectivity with Vehicle Dynamics Community

- Example:
 - Translating data from other programs
 - ADAMS/Car to CarSim converter, developed and validated by AMET S.r.l.



Available from AMET S.r.l, www.amet.it

Booth 5100

Tracking Data Sets

- Choose from multiple data base folders on start up of the program
- Display the data files used with this run

CarSim Run Control; { Aero Effects } Crosswind, Low Mu w/ ESC *

File Edit Datasets Libraries Tools View Help

Back Forward Home Previous Next New Save Undo Redo Lib Tool Parsfile Run107.par 06-10-2009 13:12:06 Delete Sidebar Refresh Help Lock

Notes Linked Data

CarSim Run Control: Crosswind, Low Mu w/ ESC

- Models: Simulink: ESC Control
- I/O Channels: Import: ESC Import
- I/O Channels: Export: ESC Export
- Animator: Camera Setup: Rear View High, Road Ref.
- Animator: Reference Frame: Camera Rear Point w/
- Vehicle: Loaded Condition: D-Class, Sedan w/ Aero F
- Vehicle: Assembly: D-Class, Sedan (Transparent, N
- Suspension: Independent Compliance, Springs, a
 - Suspension: Shock Absorber: Big Car Damping
 - Suspension: Auxiliary Roll Moment: Linear 384 N
 - Suspension: Jounce and Rebound Stops: +60 m
 - Suspension: Spring: 153 N/mm
 - Suspension: Shock Absorber: Big Car Damping
 - Suspension: Jounce and Rebound Stops: +60 m
 - Suspension: Spring: 153 N/mm
- Suspension: Independent System Kinematics: D-C
 - Suspension: Dive Angle (Caster Change): Front
 - Suspension: Longitudinal Position: Front Strut - L
 - Suspension: Camber Angle: Front Strut - Camber
 - Suspension: Lateral Position: Front Strut - Lateral
 - Suspension: Toe Angle: Front Strut - Toe Change
 - Suspension: Dive Angle (Caster Change): Front
 - Suspension: Longitudinal Position: Front Strut - L
 - Suspension: Camber Angle: Front Strut - Camber
 - Suspension: Lateral Position: Front Strut - Lateral
 - Suspension: Toe Angle: Front Strut - Toe Change
- Tire: 215/55 R17
 - Animator: Shape Assembly: Euro Sedan Tire
 - Animator: Shape File Link: Euro, Sedan Tire
 - Animator: Shape File Link: Euro, Sedan Wheel

Vehicle & Procedure

Vehicle configuration: Ind_Ind
D-Class, Sedan w/ Aero Forces

Procedure
Crosswind Test

Show more options on this screen

Run Control with Simulink

Run Now Send to Simulink Models: [v]
ESC Control [v]
 Write all available outputs
Output variables: [v]

Results (Post Processing)

Animate Set run color
Rear View High, Road Ref. (Frt. Facing) [v]
Plot Show more plots: 0 [v]

Number of live animators for this run: 0 [v]

Overlay animations and plots with other runs

Crosswind, Low Mu w/o ESC [v]
{No dataset selected} [v]
{No dataset selected} [v]
{No dataset selected} [v]
{No dataset selected} [v]

View Echo file with initial conditions [v]

CarSim
Mechanical Simulation

D-Class, Sedan w/ Aero Forces
{D-Class}

Shows links to all the data sets

Document the Run

- Make it easy to document history and purpose of runs

CarSim Run Control; { ** Quick Start Guide Example } Baseline

File Edit Datasets Libraries Tools View Help

Back Forward Home Previous Next New Save Undo Redo Lib Tool Parsfile Run248.par 06-11-2009 12:58:36 Delete

Notes Linked Data

Use this example when you follow the steps in the Quick Start Guide, a brief introduction to using CarSim.

Open the Quick Start Guide by selecting the Help menu from the menu bar on this screen, then selecting "Quick Start Guide".

The Quick Start Guide introduces the basic operation of the SGUI (Simulation Graphical User Interface), shows you how to change vehicle data, make runs, and view results using the Animator and Plotter.

NOTE: The examples provided in CarSim are designed to get you started using the software and to show you different features that are available. You can start with an existing example dataset, create a new dataset, then modify the new dataset to meet your testing requirements. That new dataset then becomes part of your database and can be used for any number of vehicles.

Record your notes here

Vehicle & Procedure

Vehicle configuration: Ind_Ind
C-Class, Hatchback

Procedure
DLC @ 120 km/h

Show more options on this screen

Run Control: Built-In Solvers

Run Math Model Models: ▼

Write all available outputs

Results (Post Processing)

Animate Set run color

3 deg. Azimuth, Veh. Ref. ▼

Plot Show more plots: 0 ▼

Overlay animations and plots with other runs

View Echo file with final conditions ▼

CarSim Mechanical Simulation

C-Class, Hatchback { CS C-Class }

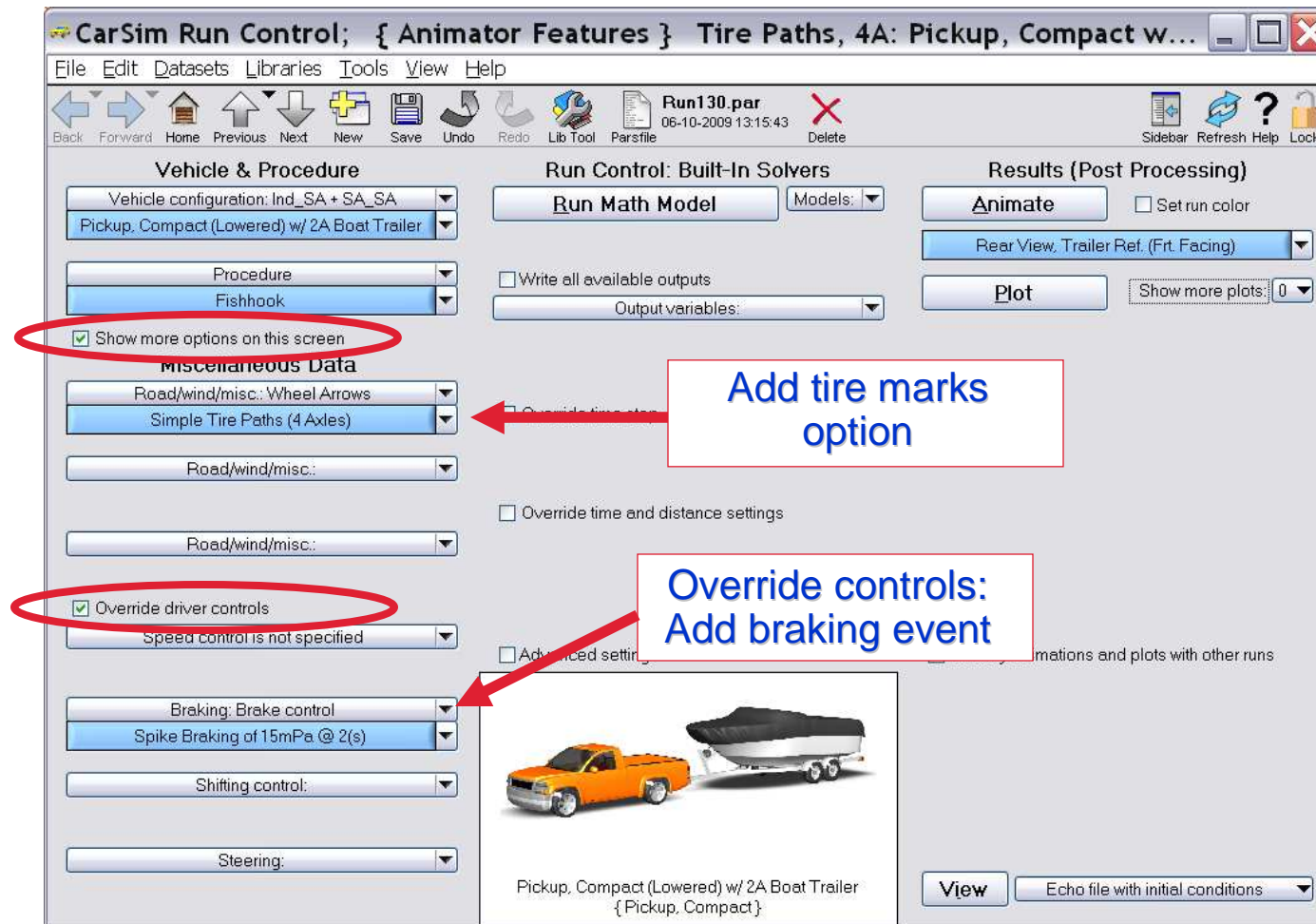
Protecting Data

- Encryption prevents vehicle data from being visible
- Complete data sets or sub-sets can be encrypted
- Encrypted components can be replaced with substitute data sets



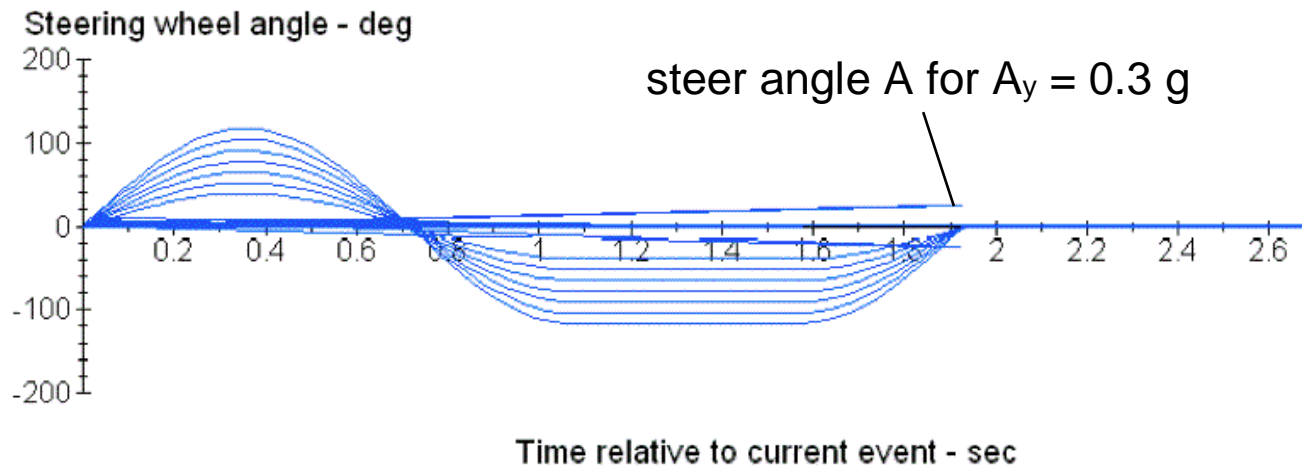
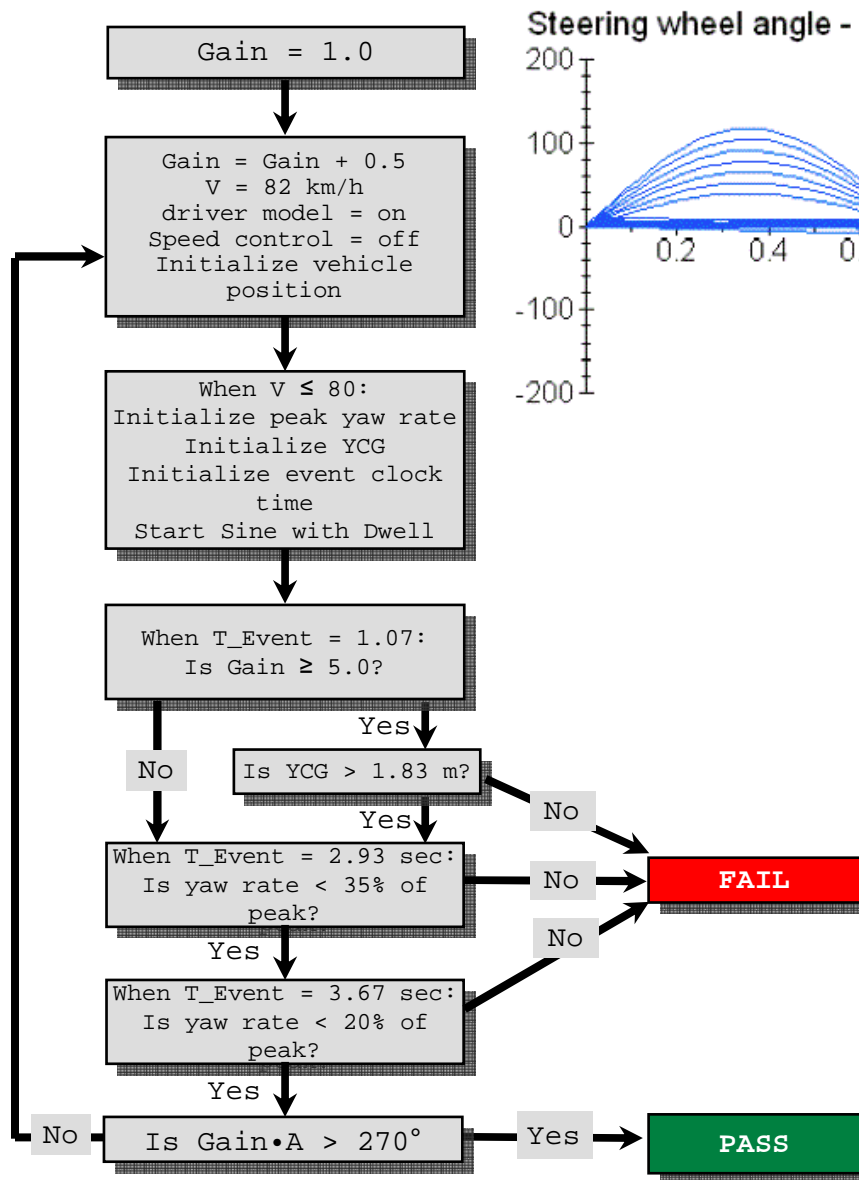
Override Controls

- Make it easy to add options and override controls at top level





Set Up Complex Test Procedures



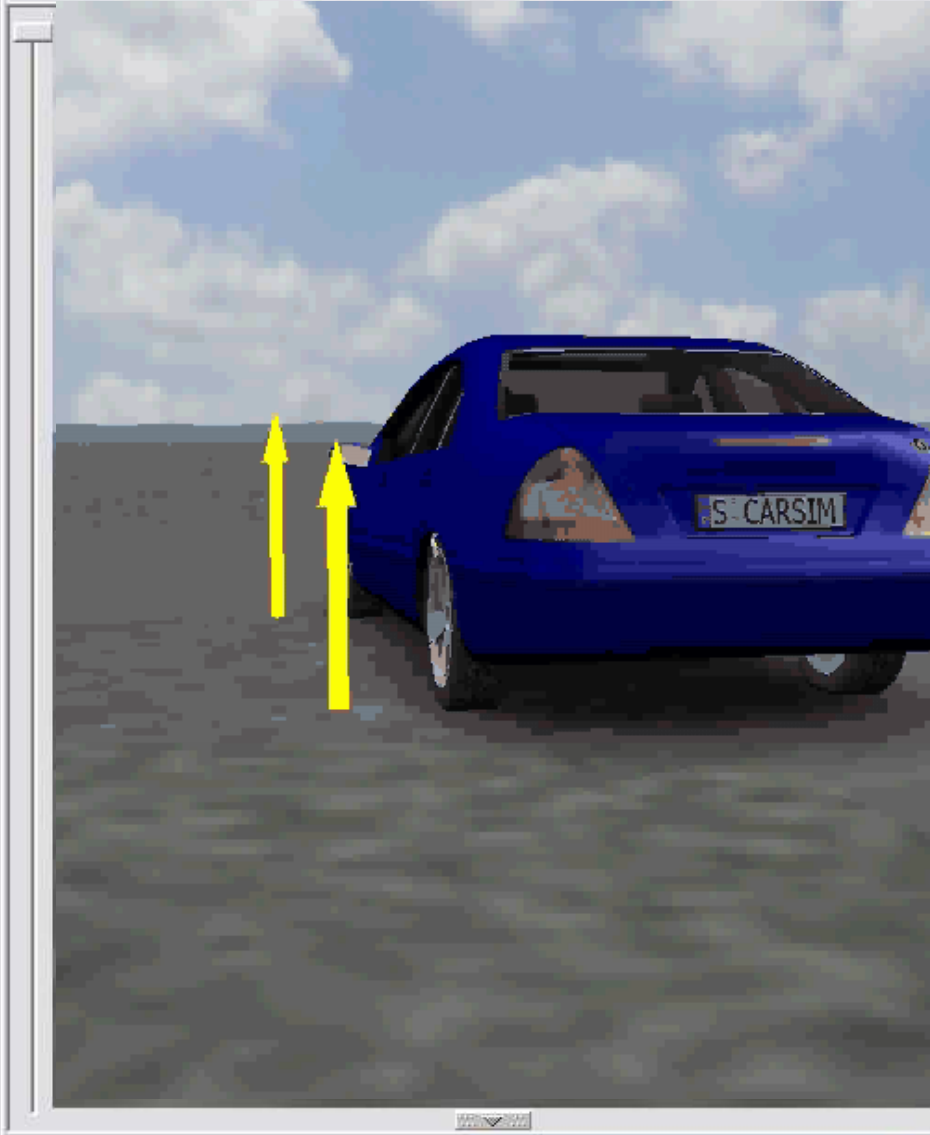
FMVSS 126 Test Procedure

- Run tests to find steer for $A_y = \pm 0.3 g$ at 80 km/h
- Run series of “sine with dwell tests”
- Check lateral position ($T = 1.07$)
- Compare yaw rate at two times to peak yaw rate
- Test until steer $> 270^\circ$

Mechanical Simulation

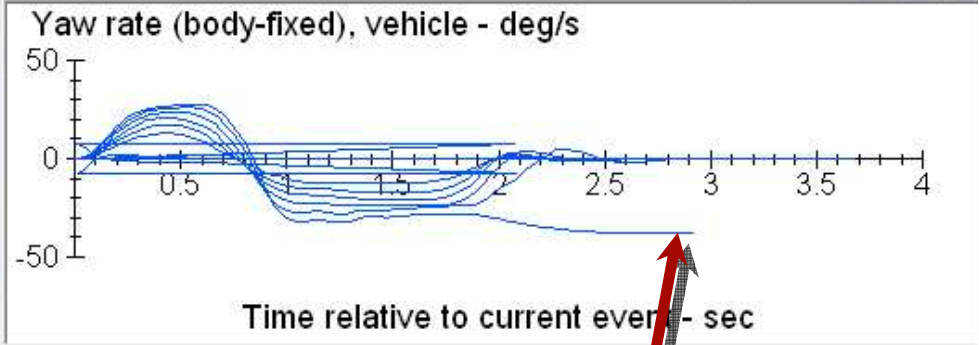
CarSim - FMVSS 126: Sedan <FMVSS 126 Example>

File Edit View Animate Help

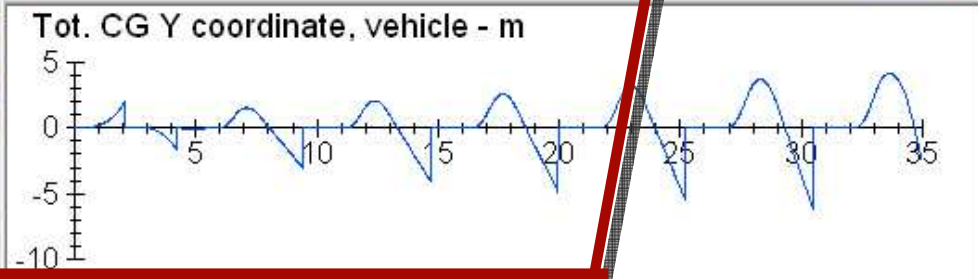


File Edit Format Data View Window Help

Yaw rate vs. T_Event : FMVSS 126: Sedan <FMVSS 126 Example>



YCG_TM : FMVSS 126: Sedan <FMVSS 126 Example>



Failure:
Yaw rate > 35% peak

216.par
2007 23:26:59 Refresh Sidebar Help

Run Control - Built-in Solvers

Run Math Model

Results (Post Processing)

Animate

Front View (Veh. Ref.)

Plot Multiple Plots

YCG_TM

Overlay Runs

- Overlay other simulation runs or experimental test results in animations and plots

CarSim Run Control; { Aero Effects } Crosswind, Low Mu w/ ESC

File Edit Datasets Libraries Tools View Help

Back Forward Home Previous Next New Save Undo Redo Lib Tool Parfile Run107.par 06-05-2009 11:54:01 Delete Sidebar Refresh Help Lock

Vehicle & Procedure

Vehicle configuration: Ind_Ind
D-Class, Sedan w/ Aero Forces

Procedure
Crosswind Test

Show more options on this screen

Run Control with Simulink

Run Now Send to Simulink Models: [v]
ESC Control [v]
 Write all available outputs
Output variables: [v]

Number of live animators for this run: 0 [v]

Results (Post Processing)

Animate Set run color
Rear View High, Road Ref. (Frt. Facing) [v]
Plot Show more plots: 0 [v]

Notes | Linked Data

This example illustrates the improvement in vehicle stability achieved with Electronic Stability Control (ESC) in high crosswinds on a low mu surface.

The crosswind fans produce 100km/h wind from the right side, then the left side.

The steering is controlled closed-loop, with the driver steering to keep the car on its path.

For this run, the vehicle is equipped with ESC.

The aerodynamic forces are displayed as single-headed arrows, located at the aerodynamic reference point. The center of pressure is not generally located at the reference point, so aerodynamic moments complete the description of aerodynamic effects. (Forces at the center of pressure are replaced with forces at the reference point and appropriate moments.) The moments are displayed as double-headed arrows located

CarSim
Mechanical Simulation

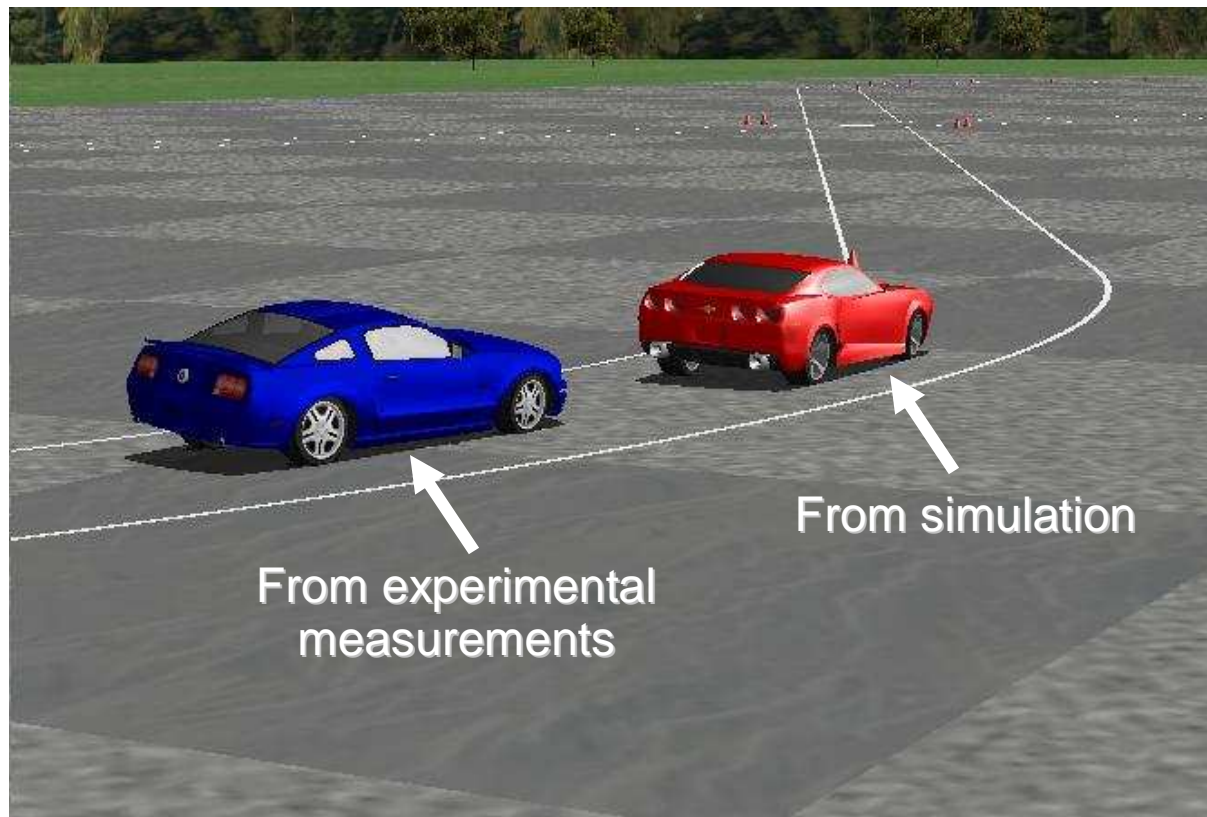
D-Class, Sedan w/ Aero Forces
{D-Class }

Overlay animations and plots with other runs
Crosswind, Low Mu w/o ESC [v]
{No dataset selected} [v]
{No dataset selected} [v]
{No dataset selected} [v]
{No dataset selected} [v]
View Echo file with initial conditions [v]

Click to overlay other results

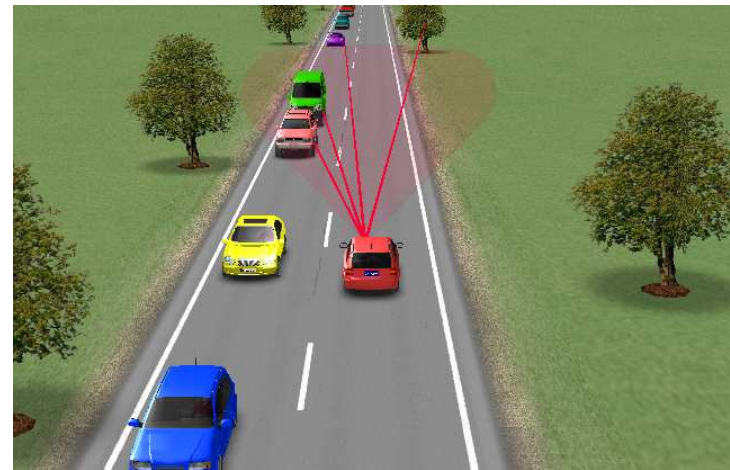
Example Animation Overlay

- Performance of the Mustang was measured on the test track
- Performance of the Camaro was simulated with Car*Sim*



Sensors and Traffic

- Sensors and traffic are created at runtime with VS Commands
- Up to 20 sensors
 - Properties: location, orientation, field of view, sensitivity
- Up to 99 stationary or moving objects
 - Properties: current location and motion variables
 - Motion variables can be computed internally or imported from other software
- Sensors report out 10 variables for each detected object
 - Used internally: e.g., for animations
 - Can be exported to other software



Sensor Description

Technical specifications of sensor

Sensor location (sprung-mass coordinates)

X	Y	Z	mm
-1200	200	1200	

Sensor aim (relative to sprung-mass X axis)

Yaw	Pitch	Roll	deg
0	2	0	

Location

Sensitivity

- Sensor range sensitivity: 100m Sensor Range
- Sensor elevation sensitivity: Unity Gain

Optional animation settings

Shape for sensor radiation field: Shape File: Rounded Cone

Color (R G B): 1 0 0.2

Translucency: .1

Show detection lines in animator

Show all detection lines

Animator shape to show line between sensor and object: Square

Color (R G B): 1 0 0.2

Appearance

Sort targets based on proximity

Objects can block (occlude) other objects

Automatically export sensor variables to Simulink/LabVIEW

The sensor field of view is limited by minimum and maximum detection angles (bearing).

Minimum: -10 deg

Maximum: 10 deg

Specify plot setups: 4

- Distance -- S1 (2 Objects)
- Bearing -- S1 (2 Objects)
- Magnitude -- S1 (2 Objects)
- Visibility -- 01

Plot Options

Scale animator shape to these dimensions

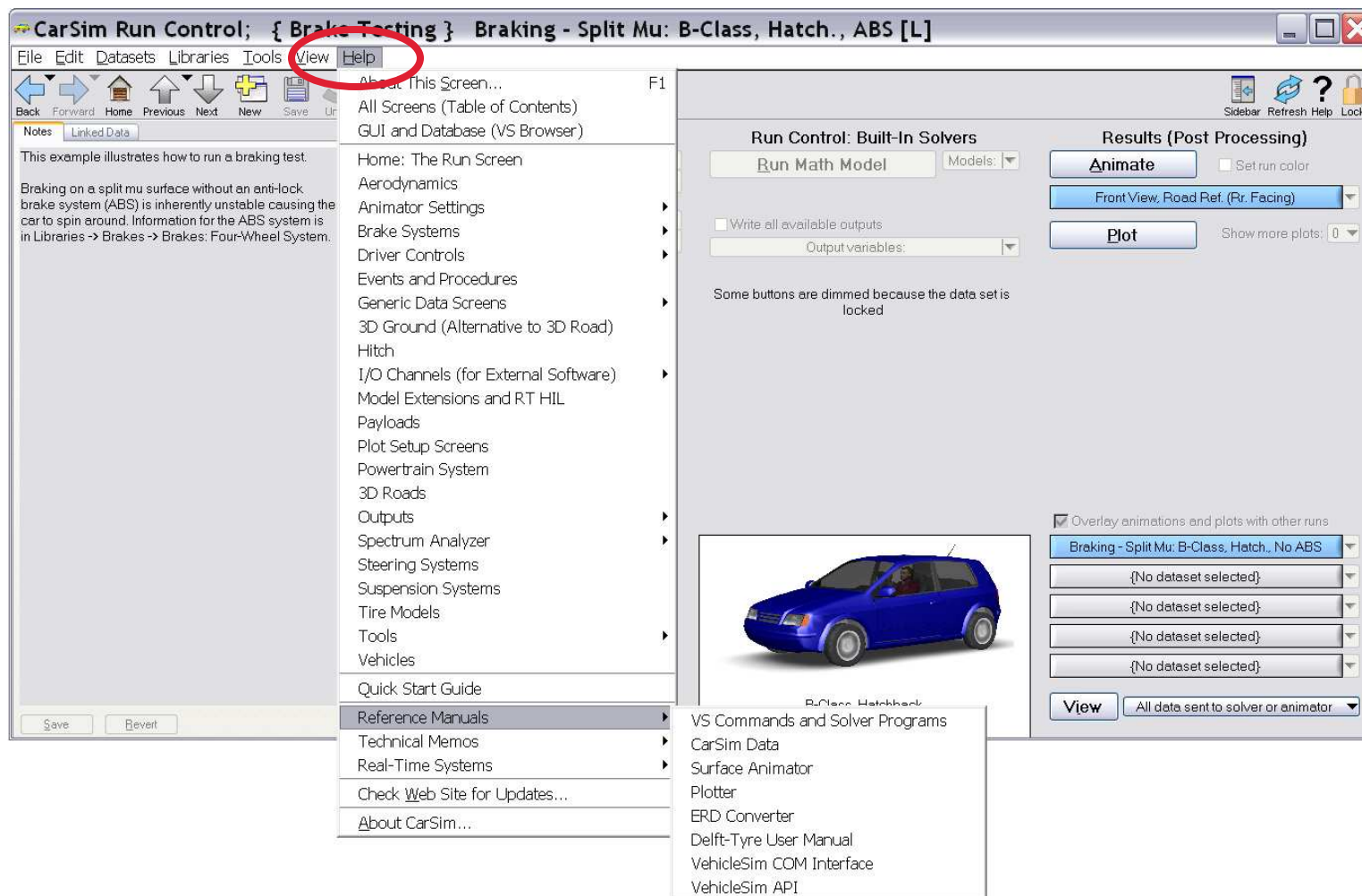
Set width automatically

Range (X)	100	m
Width (Y)	34.7	m
Height (Z)	4	m

Option for animator shape visibility/translucence: Visible based on detection magnitude

Help Resources

- Right click on any screen variable – definition and name
- “Help” menu accesses complete documentation from the Run screen



Help Resources

- “View” options access run information and documentation of variables
- E-mail for technical help at – “tech@carsim.com”

CarSim Run Control; { * CS 8.0 Traffic and Sensors } Simple Traffic Definition

File Edit Datasets Libraries Tools View Help

Back Forward Home Previous Next New Save Undo Redo Lib Tool Parsfile Run127.par 06-09-2009 14:06:05 Delete Sidebar Refresh Help Lock

Notes Linked Data

This example shows how to add traffic vehicles to a simulation.

Vehicle & Procedure

Vehicle configuration: Ind_Ind
B-Class, Sports Car (Hard Top)

Procedure
Traffic Loop

Show more options on this screen

Run Control: Built-In Solvers

Run Math Model Models

Write all available outputs

Output variables:

Results (Post Processing)

Animate Set run color

RR View, Veh. Ref., (Frt. Facing)

Plot Show more plots: 0

Overlay

View

- Echo file with initial conditions
- Echo file with final conditions
- All data sent to solver or animator
- Log file of parsfiles and events
- Simulation results (Excel)
- Simulation results (Matlab)
- ERD header file
- Multibody model description
- Imports into math model (text)
- Imports into math model (Excel)
- Outputs from math model (text)
- Outputs from math model (Excel)
- Parameters in math model (Excel)
- All data sent to solver or animator

Save Revert

CarSim
Mechanical Simulation

B-Class, Sports Car (Hard Top)
{ CS B-Class }

**Thank
You**

**For more information:
Visit Booth 5100
www.carsim.com**