CarSim

Quick Start Guide

Version 8

Mechanical Simulation
http://www.carsim.com

Table of Contents

Last updated June 2009.

1. Introduction

This guide is intended to help introduce you to CarSim. You should have CarSim installed on your computer, but no experience with using the software is assumed. If you do have some experience with CarSim, it is still a good idea to go through this guide; most people learn something from this process, even if they have used CarSim before. It typically takes about an hour and a half to cover the basics in Chapter 2 and less than an hour to cover additional features in Chapter 3.

CarSim Uses

CarSim predicts the performance of vehicles in response to driver control inputs (steering, throttle, brakes, clutch, and shifting) in a given environment (road geometry, coefficients of friction, wind). By performance, we mean vehicle motions, forces, and moments involved in acceleration, handling, and braking. Just about any test of a vehicle that would be conducted on a test track or road can be simulated.

You can study changes in vehicle behavior that result from modifying any of the hundreds of vehicle parameters, control inputs, or the driving environment. You can add vehicle elements and systems like controls (ABS, traction control, stability control) to the vehicle and use them to develop control algorithms.

Limits CarSim does not include structural flexibility, acoustics, or high frequency vibrations. It is therefore not used to study noise or structure deformations. Nor is it used to simulate individual component loads for durability analysis, because in most cases CarSim models have internal equations for system behavior (e.g., total suspension motion), rather than component behavior (e.g., tie rod or control arm motions).

You can visit Mechanical Simulation's website at www.carsim.com for more information on applications, or help in deciding if CarSim is the appropriate tool to study a particular problem.

Computer Requirements

CarSim runs on Intel PC's (or equivalent) equipped with Windows 2000, XP, and Vista. It is self-contained, requiring no additional programs or tools to run.

> **Note** CarSim math models can be extended using other simulation tools such as MATLAB® Simulink®, LabVIEW™, custom C code, etc. This introductory guide does not cover the topic of extending CarSim models.

CarSim runs on 32-bit and 64-bit versions of Windows. Both versions of the math models run at about the same speed; the main reason for using the 64-bit option is for compatibility with other 64-bit software (e.g., the 64-bit version of Simulink).

Most modern PC's are well equipped to run CarSim. Here are some general guidelines when considering computer hardware options:

- **Speed**: Get a fast CPU (it should run at a minimum of 1 GHz; faster is recommended). Although vehicle models run faster than real time, you will save time with a fast CPU. Level-2 cache is also important for speeding up runs.
- **Graphics**: Get a graphics card that supports OpenGL 2.0 hardware acceleration, with at least 128 MB of video memory (NVIDIA, ATI, or similar).
- **Storage**: CarSim requires a little under a gigabyte (GB) of disk storage. With extensive use, you will need several GB.

Notation Conventions in This Guide

The bulk of this guide is presented using a Times font. Other fonts and styles are used to convey special meanings.

- The `Courier` font is used for names of computer files and folders.
- **Bold** identifies items on the screen that you might click on—buttons, menu items, names of linked datasets, etc. Titles of screens are also shown in bold.
- Underline is used to indicate text that you might type. For example, "In the speed field, type 160."
- The instruction to *click* a control means use the left mouse button; if the right-hand button is to be used, the instruction will be to *right-click* the control.

2. Working with CarSim: A Tutorial

This chapter has a hands-on tutorial for working with CarSim. You will view simulation results with the CarSim animator and plotter and make new runs with modified controls and vehicle properties. Most sections in this chapter have short, step-by-step instructions that you can follow along to quickly perform basic actions in CarSim. All sections conclude with a short **Review** summarizing the important concepts you have covered.

Before You Start

Before starting, there are just a few requirements.

1. CarSim must be installed on your computer. If you have not yet installed CarSim, log into your computer as an administrator, insert the CD (or if it is downloaded, launch the program `Setup_CarSim_8.0.exe`), and follow the instructions.
2. You must have a license key to run CarSim. You will have one of these three setups:
    a. a license file is matched with a hardware key plugged into a USB port of the computer (the key is called a *dongle*), or
    b. a license file is matched with hardware specific to your machine, or
    c. you are connected to a network with a license server.
3. You must know where CarSim is located on your machine. The software is organized in two parts.
    a. A folder with a name such as `CarSim80_Prog` is typically installed in your `Program Files` folder. You will need to locate this folder in one of the first steps below.
    b. There is at least one database folder with a name such as `CarSim_Data` whose location is specified during installation. (The default location is in your folder `My Documents`). You must have full read and write access for this folder.

Start CarSim and Create a New Database

1. Start CarSim with one of these methods:
    a. Use the start menu shortcut: **Programs->CarSim 8.0->CarSim**.
    b. Or, double-click on the CarSim icon on your desktop.
    c. Or, double-click the file `carsim.exe` in the `CarSim80_Prog` folder.

When CarSim starts, it brings up a dialog box to select a CarSim database (Figure 1). It should show at least one available database (1).

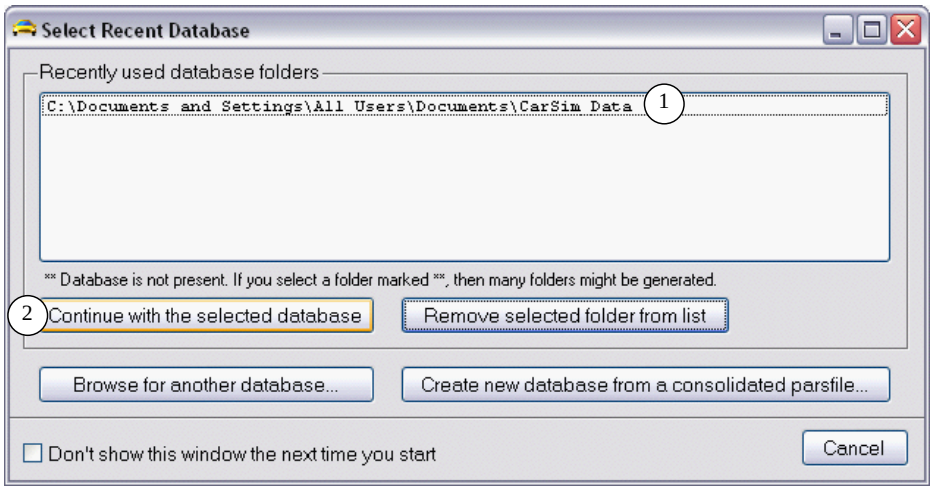


Figure 1: Select a database.

Option In the unlikely event that there is no recently used database folder, click the button **Browse for another database** and jump to step 4.

2. Click the button **Continue with the selected database** (2).

Alert If your installation is set to show license options, you will view a pop-up window with these options. If you are running with a network license server, click the **Select** button (2) to continue. There is a checkbox to skip the display of this window that you might want to set (1); do not check this if you are using a network license!

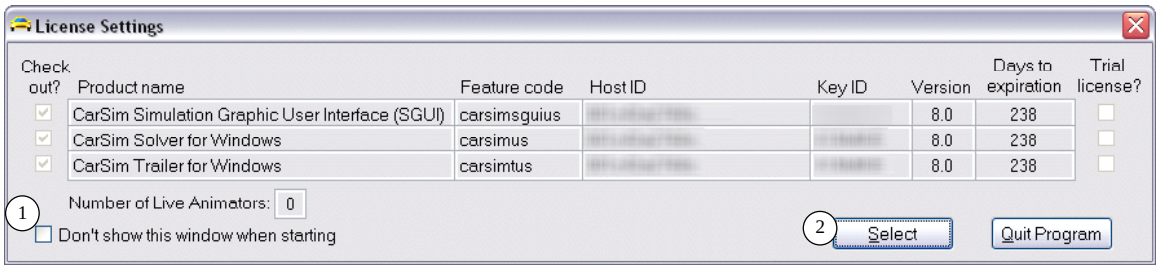


Figure 2. Popup window with license settings.

CarSim will start and show you a window whose title begins with the name **CarSim Run Control** (Figure 3).

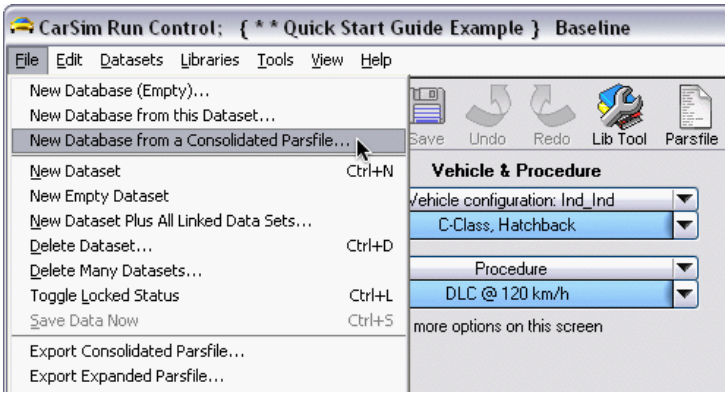


Figure 3. Make a new database from a consolidated parsfile.

3. Select the **File** menu item **New Database from a Consolidated Parsfile**.

4. The Windows file navigation window will appear (Figure 4). Navigate to the `CarSim80_Prog` folder installed on your machine (typically in `C:\Program Files`), and continue into `Resources\Import_Examples` to find the file `Quick_Start.cpar`. Select this file and click the **Load** button.

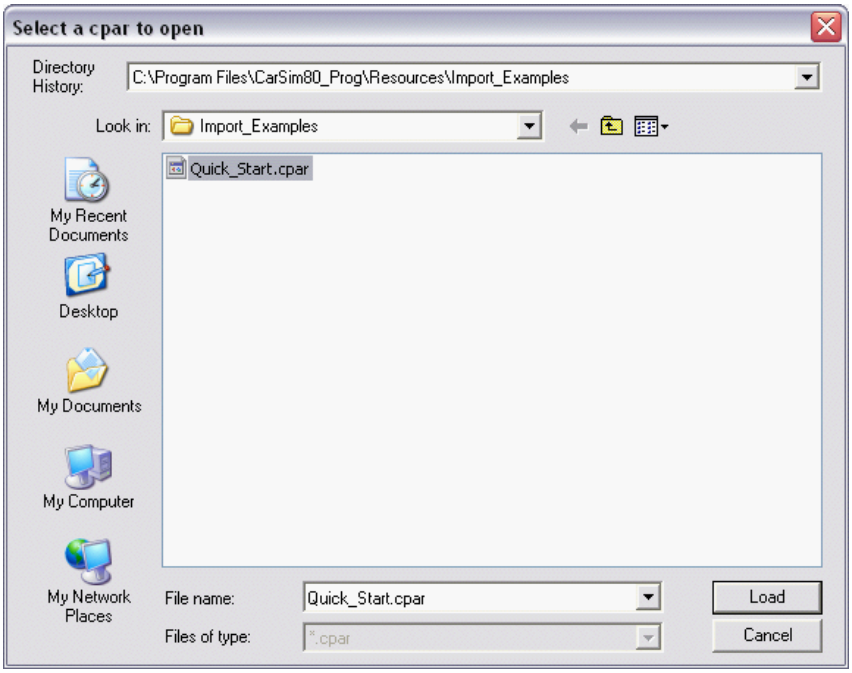


*Figure 4. Select the **Quick_Start** consolidated parsfile.*

5. CarSim will ask you to browse for a folder for the new database (Figure 5).

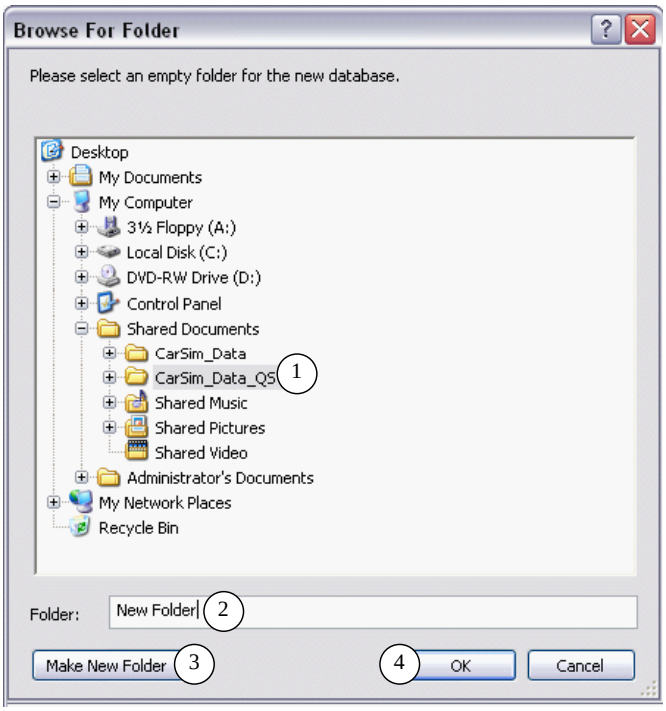


Figure 5. Create and select an empty folder for the new CarSim database.

Navigate to a location for the new database folder (for example, `Shared Documents`) and click the **Make New Folder** button (3). A new folder is created with a default name such as `New Folder` (2), and is shown selected in the browser. Type a new name, such as `CarSim_Data_QS` (1). Click the **OK** button (4) to finish.

A terminal window will pop up briefly listing files that are being copied. It will quickly disappear.

Note If your installation is set to show license options, you will again view a pop-up window with these options (Figure 2). Whenever this happens, you can just click the **Select** button to continue. (If you are not using a network license server, you can first check the box to avoid the window in future startups.)

CarSim will take a minute or two to create the new database.

Review You have just gone through the steps needed to create a clean database with only the data needed for the instructions that follow in this guide. Although these extra steps took a few minutes, they were done to ensure that what you see on your screen matches the description in this guide and to guard against modifying the examples installed in the main CarSim database while you are going through the initial learning process.

The next time you start CarSim, you will continue working in this database. The steps you have just taken for creating a new database are used mainly when starting a major new project; they are not repeated for routine use.

The CarSim Run Control Screen (Home)

CarSim opens with a view of the **Run Control** screen (Figure 6).

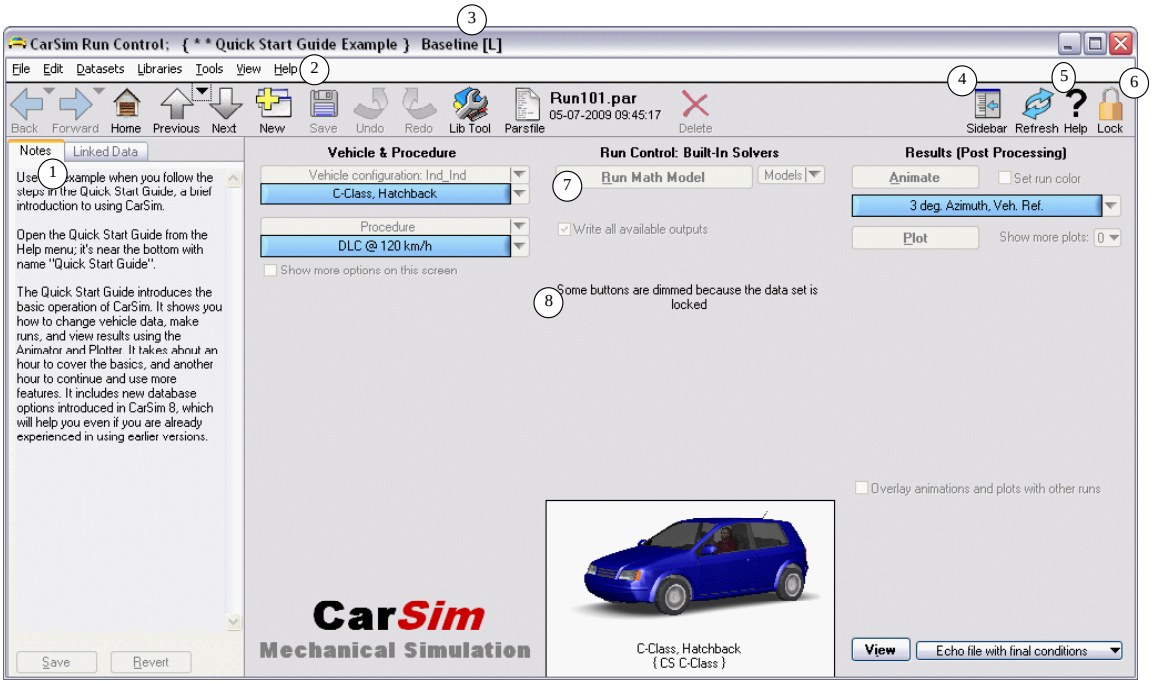


Figure 6. The CarSim Run Control screen.

1. The CarSim screen displays a *dataset* from a *library*. The window title bar identifies the library name and the full name of the dataset. In Figure 6, the library name is **CarSim Run Control**, the dataset category is *** * Quick Start Guide Example**, and the title of the dataset in that category is **Baseline** (3).

2. Use the **View** menu to set the window size for your preference.

3. Right-click and hold on the **Sidebar** button (4) for an on-line description (Figure 7).

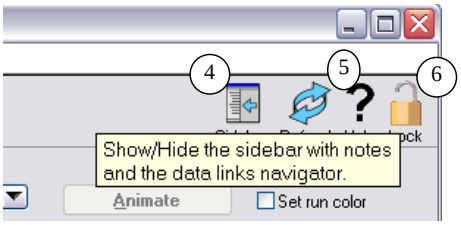


Figure 7. Right-click and hold for information about a button or other control.

> **Note** The right mouse button is used to obtain information and tips. Right-click and hold on buttons, fields, and various control objects to obtain short summaries of their functions.

The sidebar is the region on the left-hand side of the window that shows either notes or a tree of linked datasets. If the sidebar is not visible, click the sidebar button ④ to bring it into view.

4. Click the **Linked Data** tab ① (Figure 6), then the **Notes** tab to switch between the two sidebar functions. Leave the **Notes** tab selected.

5. Right-click and hold on the **Lock** button ⑥. Initially, the dataset you view just after creating a new database is locked. Several visual cues indicate it is locked:

   a. The title of the window has a suffix **[L]** ③; when unlocked the **[L]** disappears.

   b. The notes field and any fields with editable numbers or names are shown with the Windows "dimmed" color ① (light gray in the Windows XP theme that was in use when these figures were made); when unlocked they have yellow backgrounds.

   c. The **Lock** button show an image of a closed lock ⑥; when unlocked the image shows an open lock.

   d. Buttons might be dimmed, such as the **Run Math Model** button ⑦.

   e. In the case of this specific screen, a message is shown saying it is locked ⑧.

6. Click on the **Lock** button ⑥ to unlock the dataset. Notice how the screen appearance changes to visually indicate that it is no longer locked.

7. Click the **Help** button ⑤. This launches the Adobe Reader program, with a PDF documentation file for the current screen (Figure 8). At any time, the documentation for the current screen can be obtained with this button or by typing the F1 key. Alternatively, the **Help** menu ② can be used to access this and many other documents that are installed with CarSim.

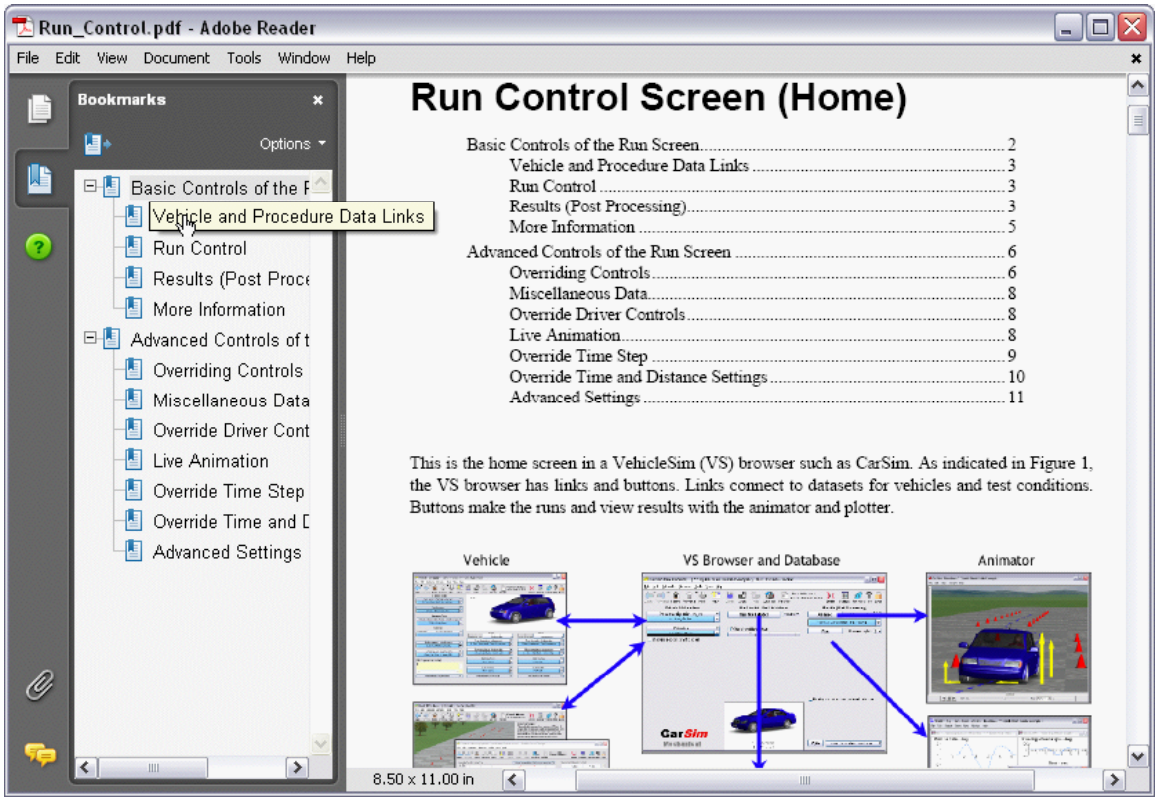


Figure 8. On-line documentation about the current screen.

> **Note** The **Help** menu has the command **Search Help**, which brings up a window in Adobe Reader for searching the entire set of CarSim documents. This is the primary tool for finding information quickly from over 1000 pages of documentation provided with the software.

After you have gone through this tutorial, you can return to the documentation for the **Run Control** screen. For now, close the PDF window and continue with the next step.

8. Right-click and hold on the **Run Math Model** button (7) (Figure 6) for an on-line description of the button, then click the **Run Math Model** button to make your first run in CarSim. A status bar appears to show the progress of the run (Figure 9). The CarSim math model runs significantly faster than real time, so this will just take a few seconds.

When the run is complete, the progress bar disappears (Figure 10). Now that there are simulation results to view, the **Animate** (1) and **Plot** (2) buttons are active.

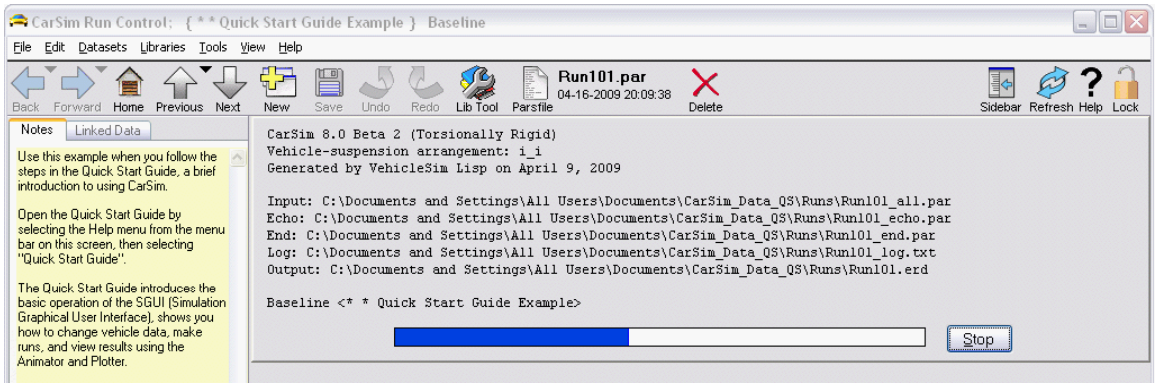


Figure 9. Progress bar that is displayed during a simulation run.

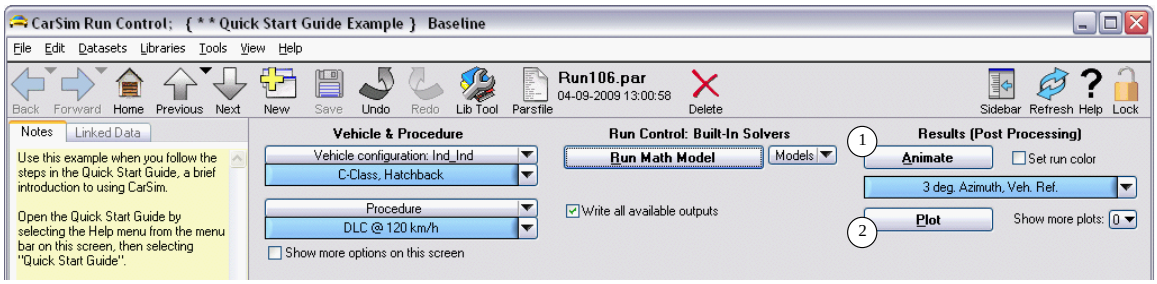


Figure 10. The Animate and Plot buttons are active after a run is made.

Review You have seen on-line help available by right-clicking, typing F1, using the **Help** button, and using the **Help** menu.

You have just made your first simulation run in CarSim from the **Run Control** screen. This screen is the starting point to access the main tools and datasets in CarSim, as indicated graphically in Figure 11. The next two sections will cover the animator and plotter.

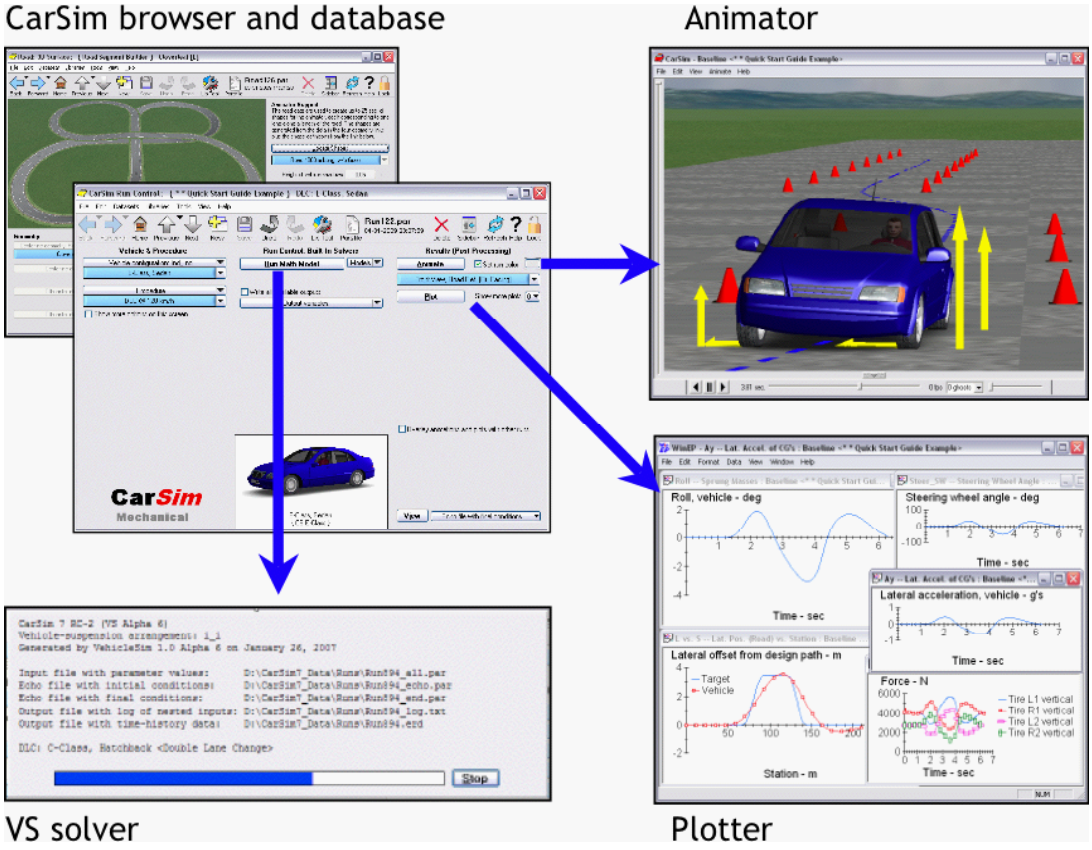


Figure 11. The four main components of CarSim.

Use the Animator

The animator combines the results of a simulated test run (made with a CarSim math model) with a simulated video camera.

1. Right-click on the **Animate** button on the **CarSim Run Control** screen (① in Figure 10) for an on-line description of the button.

2. Click the **Animate** button. A new window will appear showing an animation of the run (Figure 12.). For all of the following instructions involving the animator, numbered items refer to this figure.

> **Note** If the animator fails to run or runs very slowly, you might need to adjust Windows settings for your computer. (This is more likely to be problem with laptops that have lower-quality graphic accelerator hardware.) If there is a serious problem with the animator display, please see the **Animator Performance** tech memo (use the CarSim **Help** menu and go to the **Technical Memos** submenu).

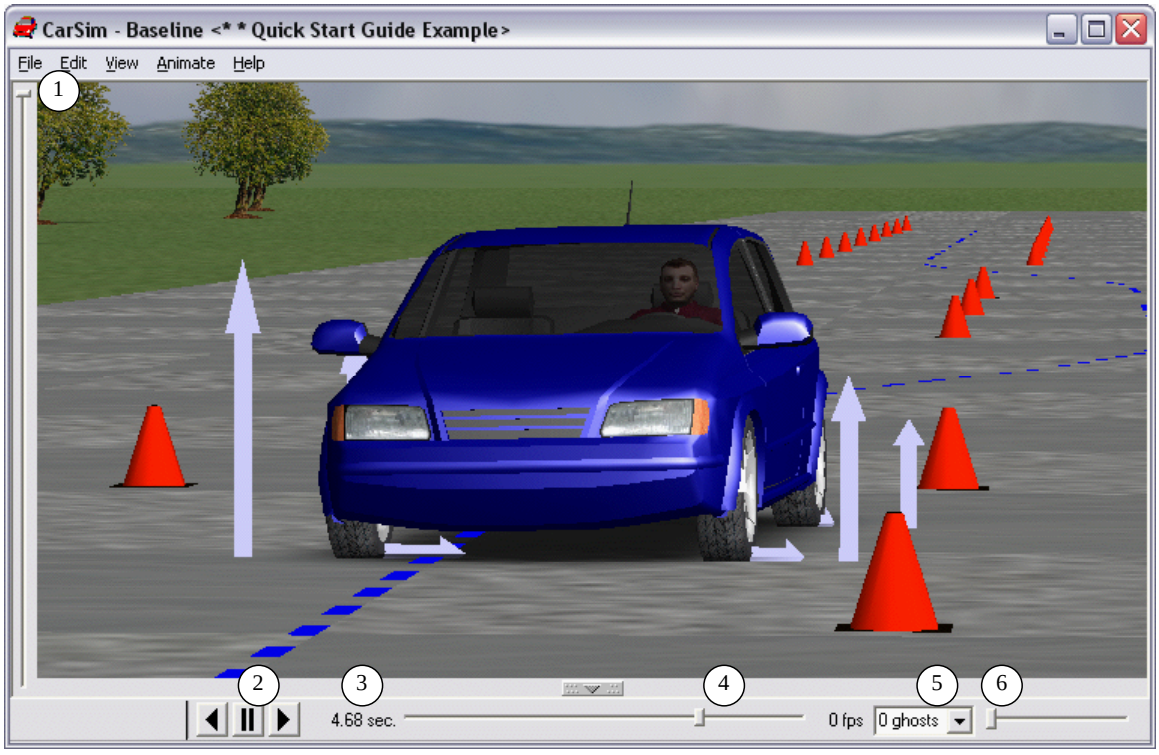


Figure 12. The animator screen.

3. Click and hold a mouse button down in the animation display region and use simple sweeping motions to move the simulated camera:

a. Click and hold anywhere in the viewing area with the left mouse button, then sweep left and right to circle around the vehicle.

b. Click and hold anywhere in the viewing area with the left mouse button, then sweep up and down to move the camera up and down.

c. Click and hold anywhere in the viewing area with the right mouse button, then sweep up and down to move the camera closer or further away from the vehicle.

d. Hold the shift key down and Click and hold in the viewing area with the left mouse button. Sweep in any direction to "drag" the viewing area. This changes the aim of the camera, while leaving its position unaffected. A cross-hair will appear to show you the new location.

e. If you have a three-button mouse or clickable scroll wheel, press the middle button and sweep up and down to zoom in and out. (This does not move the camera, but changes the camera zoom.)

f. If you have a three-button mouse or clickable scroll wheel, hold the shift key down and at the same time press the middle button and sweep up and down. This does a simultaneous zoom and tracking (moving the camera), keeping the image of the vehicle about the same size, while changing the perspective effects related to

distance. (Move down to simultaneously track back and zoom in; move up to track in and zoom out.)

4. Notice the slider at the bottom of the screen ④. (If the controls shown in the figure are not visible in your window, select the **View** menu item **Toolbar** to display them). As the animation runs, the slider moves from left to right. The current time (e.g., 4.68 sec) is also shown ③. The animator has controls for starting, stopping, and jumping to any point in the simulated run.

a. Pause the animation by clicking the pause button ② or pressing the space key on your keyboard.

b. Play the animation forward by clicking the forward arrow (near ②) or typing Ctrl+→.

c. Play backward by clicking the back arrow (near ②) or typing Ctrl +←.

d. When the animator is stopped, move the slider ④ to locate any point in the run.

e. When the animator is stopped, use the → or ← keys to jump the slider forward or backward in the animation.

f. Type Ctrl+S to play the animation from the start.

5. The playback speed is normally real-time. However, you can slow it down almost to a stop using the vertical slider bar on the left side of the window ①.

a. While the animation is playing, move the slider bar down to see the effect of slow motion. You can also move the bar with the ↓ and ↑ keys. If you have a mouse with a scroll wheel, you can also use the scroll wheel to move the slider.

b. Bring the animation speed to extreme slow motion, such that the spin of the wheels is barely visible. Toggle between forward and reverse using Ctrl+→ and Ctrl+←.

6. The animator has a ghost trail option. Pause the animation ② and move to a time in the middle of the run (move the slider ④) to see this effect.

a. Use the ghost control ⑤ to set the number of ghosts to 3.

b. Use the slider ⑥ to adjust the time interval (distance) between images.

7. The animator can display shapes using solid surfaces or wireframes. Use the **View** menu item **Wireframe Rendering** or type the keyboard command Ctrl+W to toggle between viewing modes.

8. If the animator is still playing in slow motion, restore it to full speed. Then exit the animator by clicking the **X** button in the upper-right corner of the window. You should once again be viewing the **CarSim Run Control** screen (it may have been hidden in the background).

Review You have now gone through the main interactive controls for using the animator. The following sections assume you are comfortable manipulating the view and working with the animator. For more complete reference information, use the CarSim **Help** menu and access the **Surface Animator** reference manual (in the **Reference Manuals** submenu).

View Plots

Although the animator offers a quick way to see a simulated test such as the example double lane change, the plotter is the tool most frequently used to study the vehicle behavior. The plotter in CarSim is called WinEP (Windows-based Engineering Plotter).

1. From the same **Run Control** screen, click the **Plot** button screen (② in Figure 10). In a few seconds, the WinEP window will appear showing plots for variables of interest in the simulated double lane-change procedure (Figure 13).

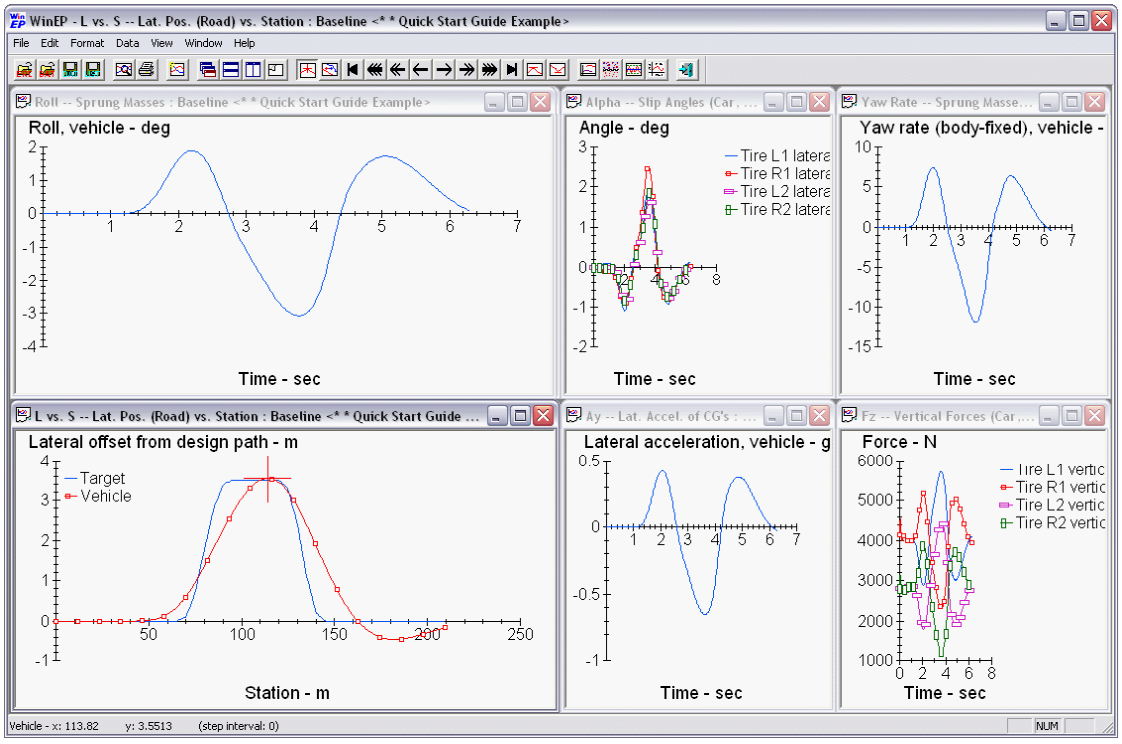


Figure 13. Viewing plots in WinEP.

2. If this is the first time the plotter has been run on this computer, make some optional adjustments for better viewing.

a. Check to see if the toolbar is visible (Figure 14). If the toolbar is not visible, show it using the **View** menu.

Figure 14. Toolbar for WinEP.

b. If the plot window is small, enlarge by double-clicking the title bar or clicking the zoom box in the upper-right corner of the window, then click a tile button  , or select a **Tile** option from the **Window** menu. After you exit the plotter, it will open in the new layout the next time.

3. Each individual sub-window can be moved or re-sized as desired. For example, try zooming one of the plot windows by clicking the maximize box in its upper-right corner. Press the Page-Down key to cycle through the open plots. Other options for controlling and navigating among the windows are provided under the **Window** menu.

4. To view a portion of any plot in more detail, click and hold the left mouse button in the plot area and drag to create a rectangle. When you release the button, the plot will be re-drawn to show the region you selected.

5. To restore the original scaling, type Ctrl+R (a shortcut for the **Format** menu item **Redraw Original Scale**). Alternatively, click the toolbar button  .

6. The plotter can show the numerical X and Y values for any point in any plot.

a. Type Ctrl+D (a shortcut for the **Data** menu item **Show Data Points)**, or, click the toolbar button  . A cross-hair cursor appears on the first point in the first dataset in the active plot window.

> **Note** The cross-hair cursor is at the left edge of the plot area. Because it lines up with the vertical axis, it is hard to see until it has been moved.

The values of the X and Y variables are shown in the status bar (the strip at the bottom of the window).

The cursor position is controlled by key presses or by selecting an item from the **Data** menu (under the sub-menu **Cursor Position Info**). Although the menu is functional, it is mainly used as a form of on-line documentation for reminding you which keys can be used to control the cursor.

b. Move the cursor to the right using the → key. Move it more quickly using the Shift key and → key together (Shift+→). Move it even more quickly using Ctrl+Shift+→. To move to the left, use ←, Shift+←, and Ctrl+Shift+←. There are also buttons in the toolbar for moving the cursor in several increments:

c. To move the cursor to a different dataset in the same plot (assuming the plot has an overlay of two or more datasets), hit the Tab key or click the toolbar button  .

d. Use the Home and End keys to jump to the beginning and end of the plot. Or, use the toolbar buttons  and  .

e. Use the ↑ and ↓ keys to jump to the maximum and minimum values. Or, use the toolbar buttons  and  .

7. Exit WinEP to return to the **CarSim Run Control** screen.

> **Review** You have now gone through the main interactive controls for using the plotter. The following sections assume you are comfortable zooming and viewing numerical values using the cross-hair cursor. For more complete reference information, use the CarSim **Help** menu and access the **Plotter** reference manual (in the **Reference Manuals** submenu).

Run with a New Procedure

You should be viewing the **CarSim Run Control** screen with the dataset named **Baseline** in the category **Quick Start Guide Example**, shown again in Figure 15.

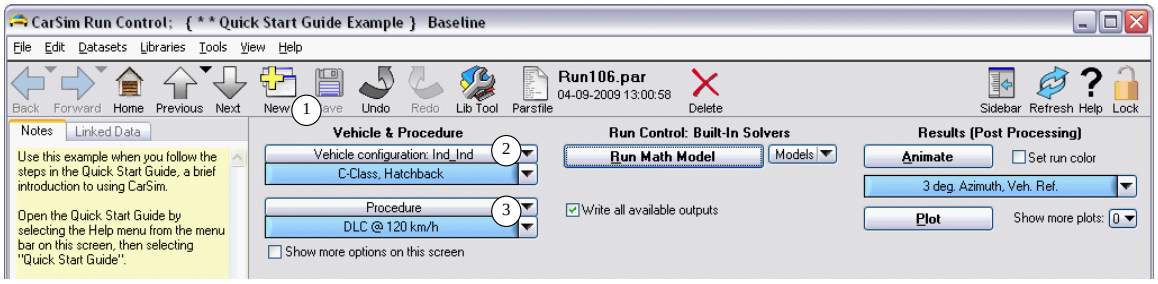


Figure 15. The CarSim Run Control screen (repeated from earlier figure).

In the previous sections, you ran the vehicle in a baseline condition, and viewed results using the animator and plotter. To do this, you used the three main buttons shown in Figure 15: **Run Math Model**, **Animate**, and **Plot**. The two areas that have not yet been investigated are in the upper-left part of the screen under the title **Vehicle and Procedure** (items ② and ③). These link to datasets that define the properties of the simulated vehicle and procedure. In this section, you will run a new test with a new procedure involving a different test speed.

1. Right-click the **New** button ① for an on-line description of the button. Then click the **New** button ①.

The menu bar and tool bar will be covered with a window that prompts you to enter a title for the new test (Figure 16). Enter a new name in the title field: My New Test ①. Click the

Set button (2) to set the new name. The new screen display is nearly identical to the previous one, except that the **Animate** and **Plot** buttons are dimmed because the run has not yet been made (compare Figure 15 and Figure 17).

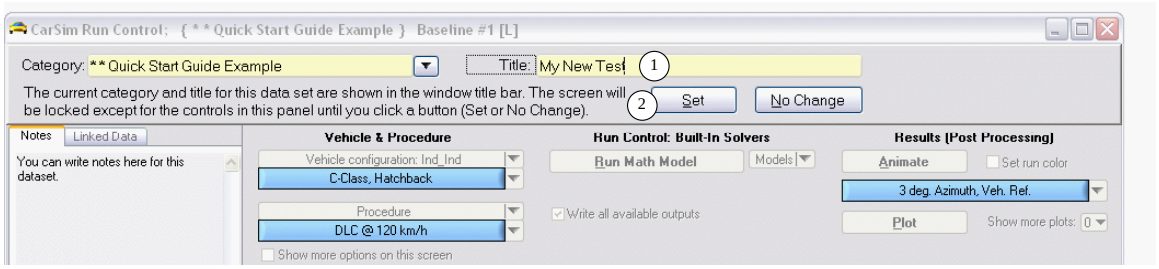


Figure 16. Setting the name of a new dataset.

2. Notice the three controls that are identified by circled numbers in Figure 17. All three involve another dataset that is linked to this one. Right-click on each for on-line descriptions:

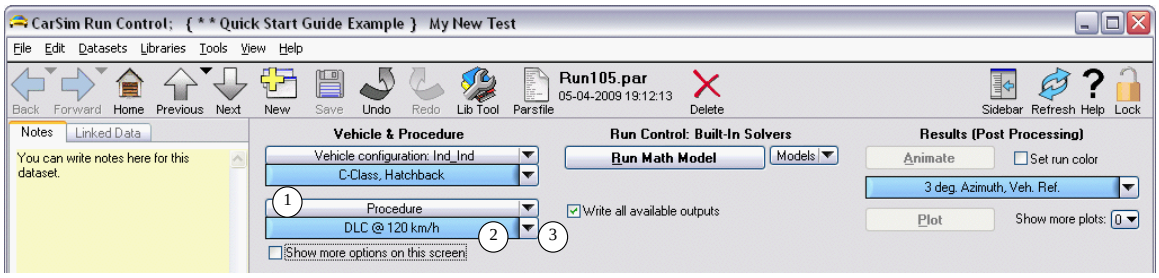


Figure 17. The CarSim Run Control screen for a new dataset.

a. The top control labeled **Procedure** (1) is used to clear the link or switch to a different library of datasets.

b. The blue button (2) is a link to a dataset. Right-click to identify the library (**Procedures**), the dataset **({Handling Testing} DLC @ 120 km/h**), and the underlying file name (depends on the installation details).

c. The drop-down control (3) next to the blue button is used to select a dataset from the linked library or create a new dataset and immediately link to it.

> **Note** These three controls all relate to the same linked dataset. Similar groups of three controls are used throughout CarSim. In future instructions, the group of three controls is sometimes identified as one item to shorten the descriptions.

3. Use the drop-down dataset selector (3) (under **Procedure**) and choose the option to **Copy and Link Dataset** (Figure 18).

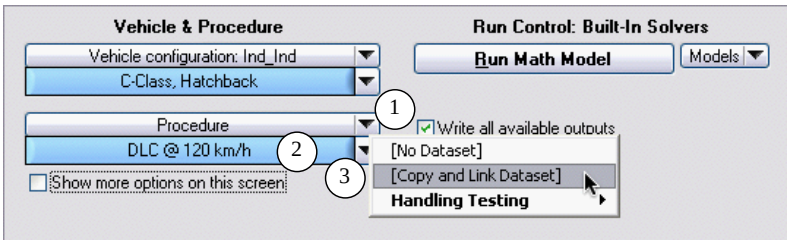


*Figure 18. Use the **Copy and Link Dataset** command to copy the existing dataset.*

This action brings up a dialog box where you set the title and category for the dataset that is about to be created (Figure 19). The existing title indicates that this is a double lane change (DLC) and that the speed is 120 km/h.

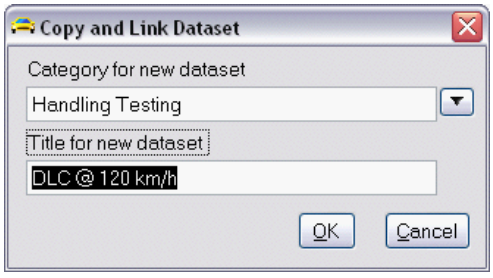


Figure 19. Specify title for new dataset.

Change the speed in the title from 120 to 150, and then click the OK button. The **CarSim Run Control** screen now shows the modified link (2) (Figure 20). This action created an identical copy of the original linked dataset. Your next step is to edit the dataset to change the test speed.

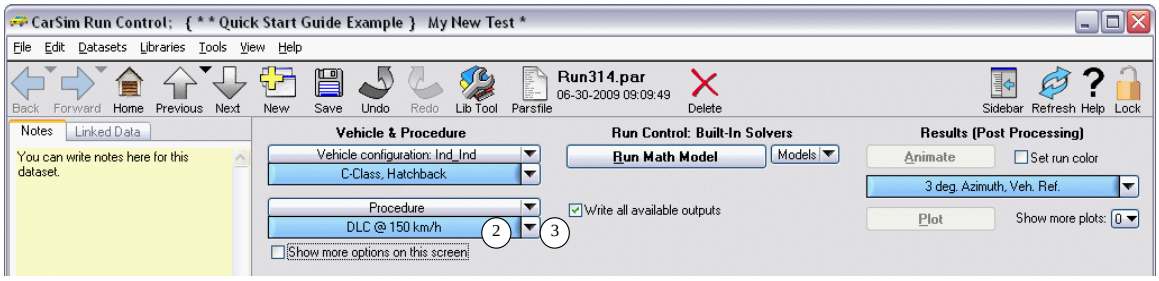


Figure 20. Run screen with link to newly created procedure dataset.

4. Click the blue button (2) (Figure 20) to view the newly created dataset (Figure 21).

This screen specifies details about a vehicle test procedure. It has links to datasets for driver controls, additional data that include a 3D road, starting and stopping conditions, and definitions of plots of interest. Although it has a new title, the rest of the information on the screen is an exact copy of the dataset that was used for the baseline run.

5. The speed shown in the yellow field (3) is 120. Change it to 150 km/h.

6. The **Notes** yellow field (2) has text that states "You can write notes here." Delete that text and write some documentation about your new dataset (Figure 21).

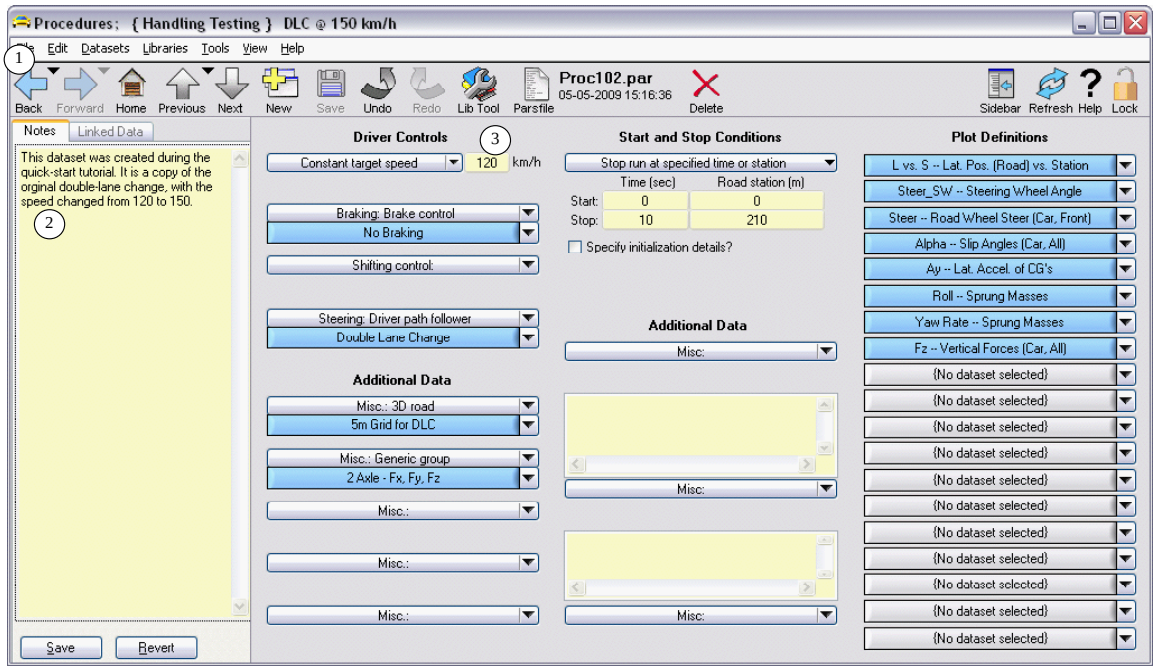


Figure 21. Procedure screen for newly created dataset.

7. Right-click on the **Back** button (1) to confirm what it does, then click it to return to the previous library screen — the **CarSim Run Control** screen (Figure 20).

8. Click the **Run Math Model** button. As before, a status bar shows the progress of the run.

9. When the run is complete, the **Animate** and **Plot** buttons become active. Click the **Animate** button to run the animator and view the new simulated behavior. After viewing the results, close the animator.

10. On the lower-right corner of the screen, right-click the checkbox **Overlay animations and plots with other runs** (1) (Figure 22), and then check the box. When checked, results of multiple runs can be overlaid; several potential links appear for selecting runs to overlay.

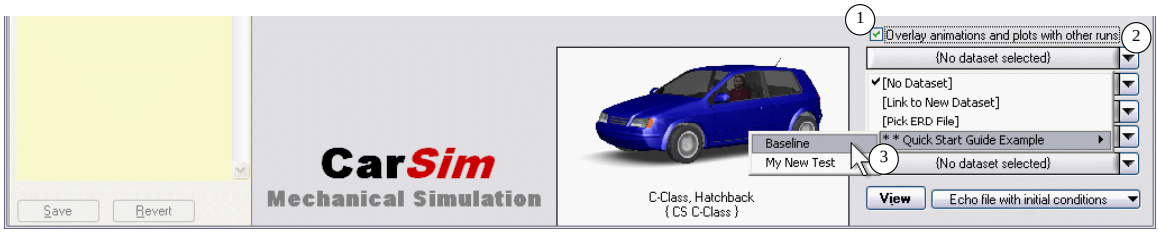


Figure 22. Overlay a new run with the baseline run.

11. Press the drop-down control (2) to select an existing run to overlay. Choose **Baseline** (3).

12. Next to the **Animate** button, right-click the checkbox **Set run color** ① (Figure 23). The pop-up help indicates the vehicle color can be set here; check the box to reveal a color selector ②.

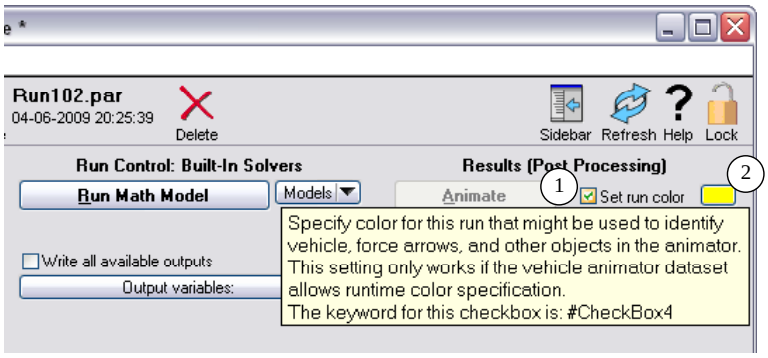


Figure 23. Option to set a run color.

13. Press the color selector button ② to display a color palette (Figure 24). For example, choose yellow (the baseline vehicle was blue).

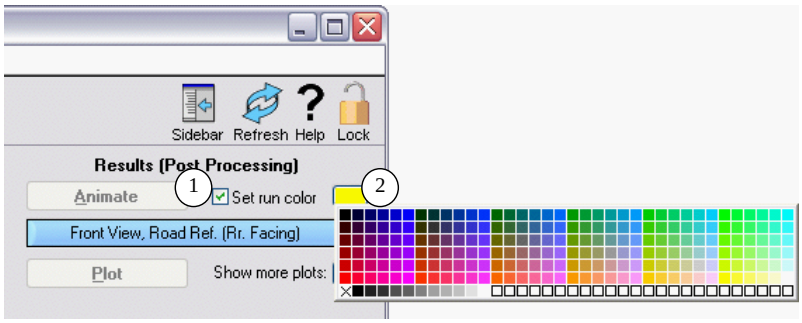


Figure 24. Color selector palette.

14. Click the **Animate** button to view both runs in the animator (Figure 25). After viewing the results, close the animator.

Review You have navigated through the CarSim database, created a new procedure dataset named **My New Test**, and used it to make a new run. You documented your new dataset using the **Notes** field. You have overlaid results from multiple runs in the animator and set the color from the main screen to more easily identify vehicles from the different runs.

In the next section, you will create some new datasets from scratch to define a vehicle under a new loading condition, run the test, and see how the behavior is affected.

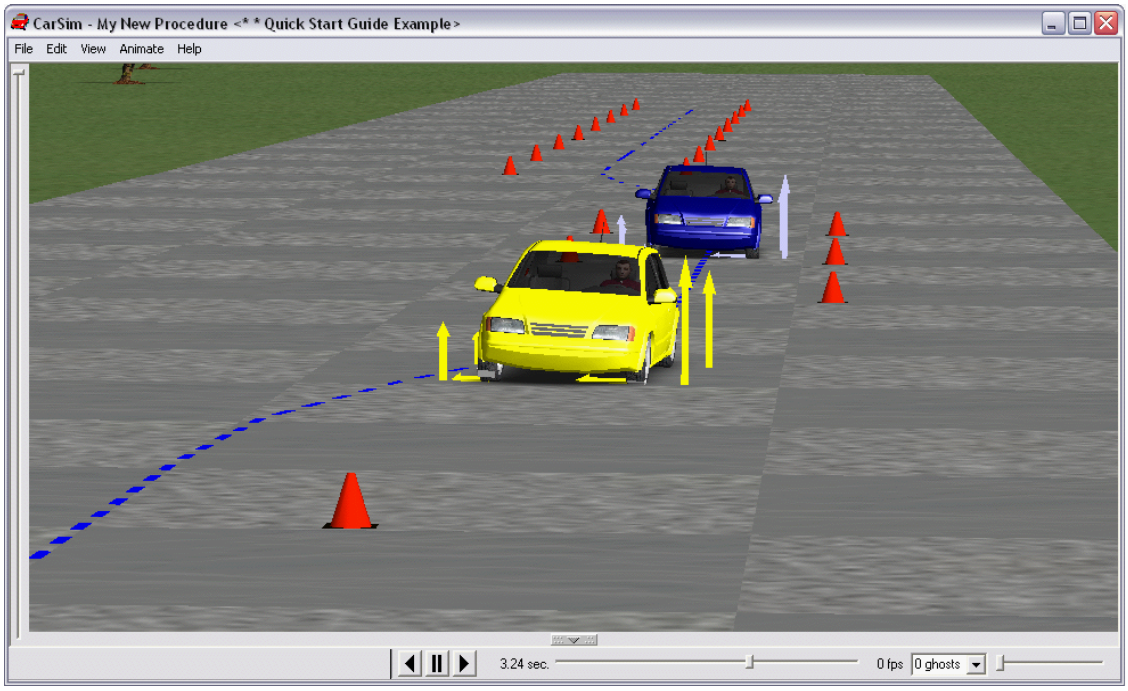


Figure 25. Animation with overlay of two runs.

Run a Vehicle with a New Load Condition

Continue with the **CarSim Run Control** screen, with the dataset created in the previous section: **{ * * Quick Start Guide Example } My New Test**.

1. Click the **New** button ① (Figure 26) to create another new dataset, and give it the name My New Load Condition. Once again, the screen shows your new title. As before, the **Animate** and **Plot** buttons are dimmed because the run hasn't been made yet.

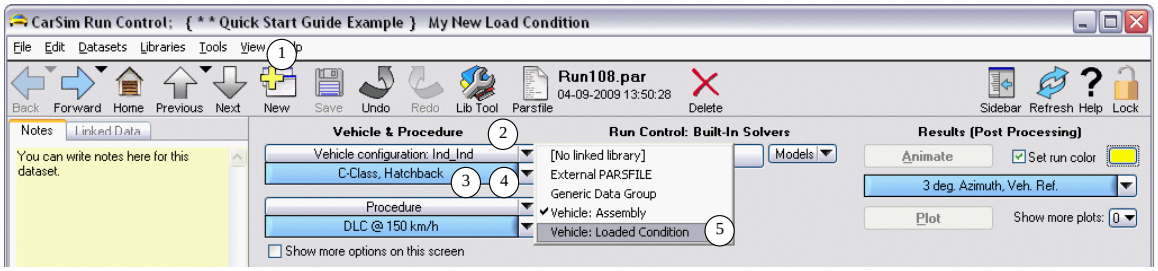


Figure 26: Selecting a different library of vehicle datasets.

2. Use the drop-down control labeled **Vehicle configuration: Ind_Ind** ② and select the library **Vehicle: Loaded Condition** ⑤.

This switches to a library of vehicle datasets that include loading conditions (passengers, payloads, etc.). The link button ③ is now gray and labeled **{No dataset selected}**, to indicate that you need to pick a dataset in the newly linked library.

3. Use the drop-down control ④ and choose the option **Link to New Dataset**.

This action brings up a dialog box where you specify the title and category of the newly created dataset (Figure 27). Enter the title Roof-top load condition ①, and click the **OK** button ②. The **CarSim Run Control** screen now shows a link to this new dataset ③ (Figure 28).

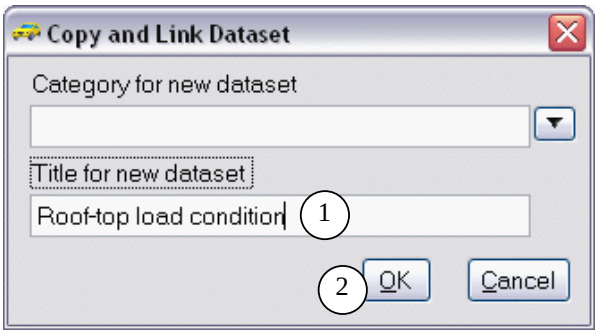


Figure 27. Specify title and category for newly created loaded vehicle dataset.

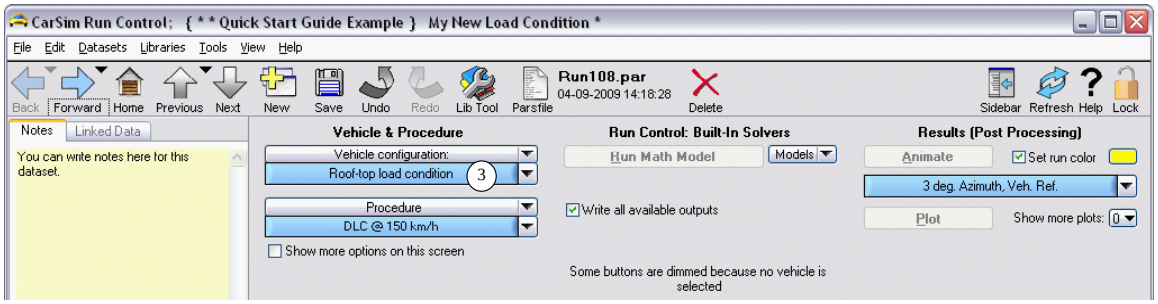


Figure 28. Run screen with link to newly created vehicle dataset.

Although the vehicle dataset has been created and linked, it does not yet have any values. CarSim cannot determine the vehicle layout. (Does it have independent or solid axle suspensions? Does it have a trailer?) Without the layout information, the **Run Math Model** button is dimmed to indicate a run cannot yet be made.

In the next few steps, you will provide the necessary information.

4. Click the blue button ③ to view the newly created dataset (Figure 29). The screen shows no data values at this time; in the next few steps, you will link to the original vehicle dataset ① and then add a link to a load ②.

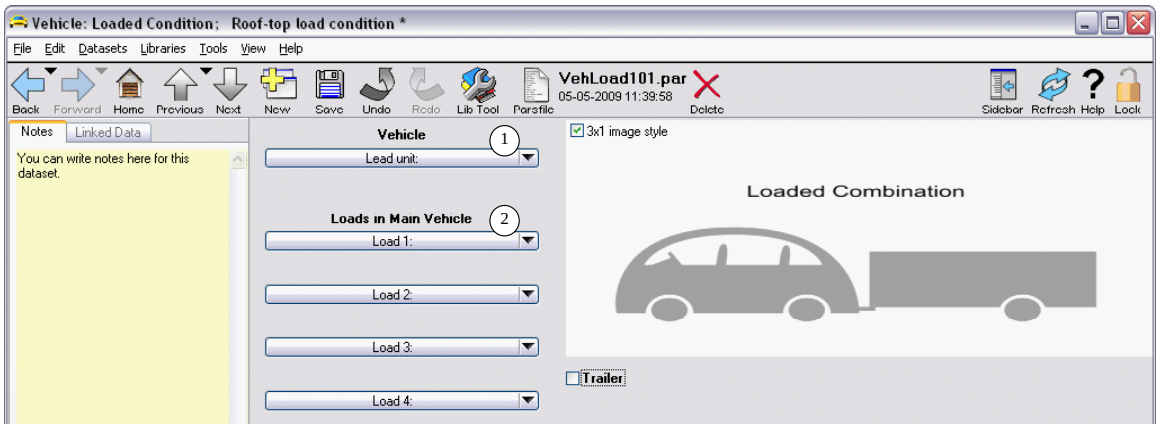


Figure 29. Newly created vehicle dataset.

5. Use the drop-down vehicle library control ① to select the vehicle assembly library ② (Figure 30).

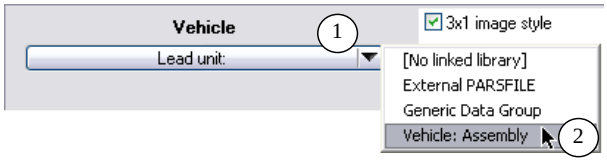


*Figure 30. Select the **Vehicle: Assembly** library.*

This action should immediately display more controls underneath ③ (Figure 31). Use the drop-down dataset control ③ to view the datasets in the **Vehicle: Assembly** library, and choose **CS C-Class->C-Class, Hatchback** ④. The screen changes (Figure 32); the selected dataset is now named in the blue link button ① and the image is updated to show the hatchback ②.

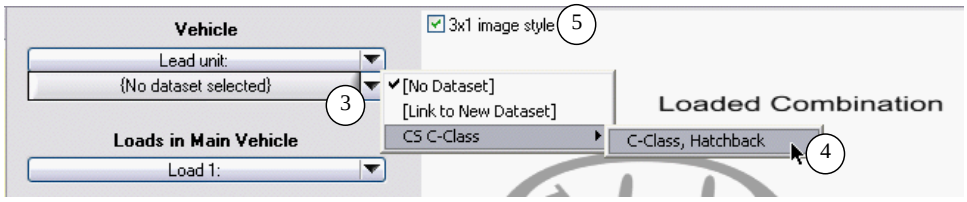


Figure 31. Select the vehicle assembly dataset for the C-class hatchback.

If the **3x1 image style** box ⑤ is checked, uncheck it to adjust the display of the vehicle image.

6. Use the drop-down library control ③ to select the **Payload: Box Shape** library ④. This action should immediately display more controls underneath to access a payload dataset. (Figure 34 shows the appearance of the screen after step 7.)

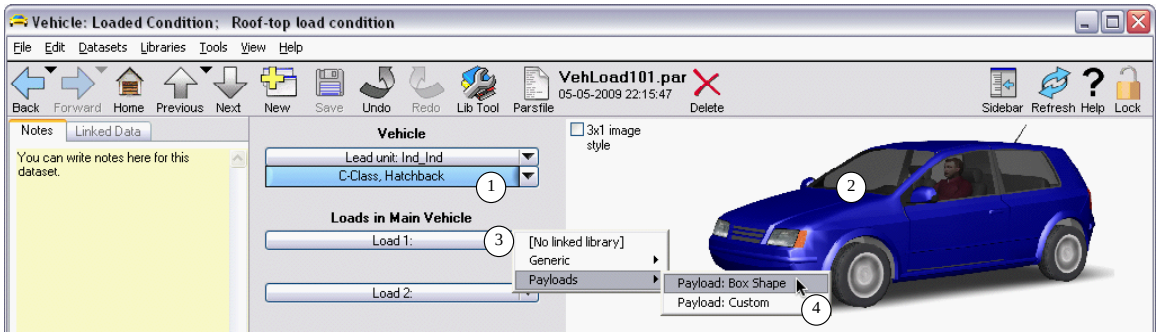


*Figure 32. Select the **Payload: Box Shape** library.*

7. Use the drop-down dataset control for the payload (6) and choose the option to **Link to New Dataset**. This brings up a dialog box asking for the name and category to be given to the newly created dataset (Figure 33). Enter the title Luggage on Roof – 80 kg, and click the **OK** button. The **Vehicle: Loaded** screen now shows a link to this new dataset (Figure 34).

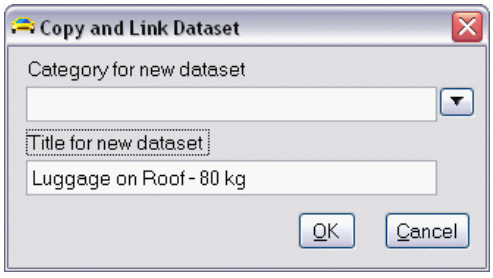


Figure 33. Name the new payload dataset.

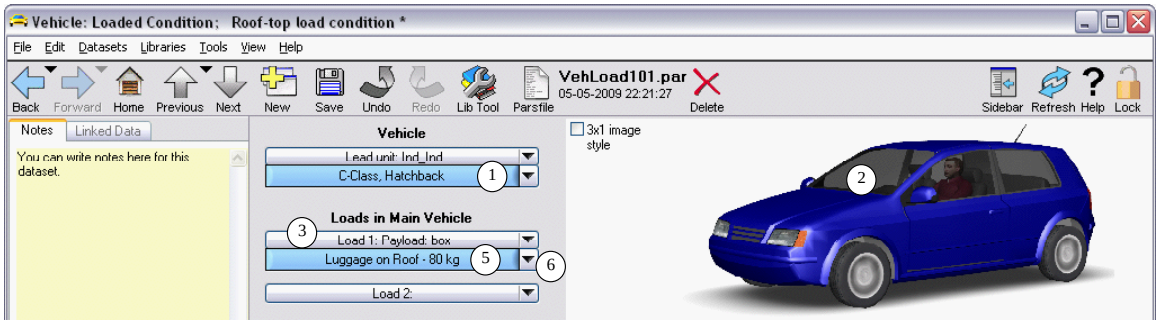


*Figure 34. The **Vehicle: Loaded Condition** screen with links for a vehicle and payload.*

8. Click the blue link button (5) (Figure 34) to view the newly created dataset (Figure 35). The yellow fields are initially all blank.

Fill in values to match those shown in the figure. Start with the field in the upper-left part of the display (3), and use the Tab key to go to the next field after entering a number.

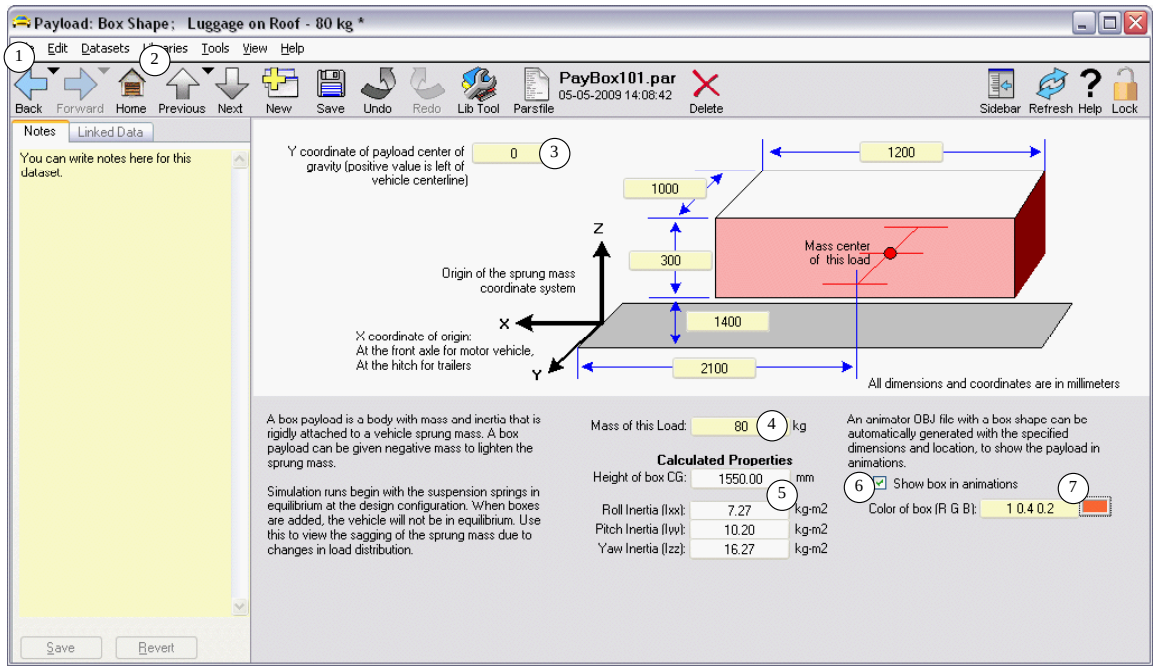


Figure 35. The newly created rectangular payload dataset.

Note that when you enter a mass (4), CarSim calculates moments of inertia and the C.G. height of the box (5) from the dimensions and mass.

Be sure to check the option for showing the box in the animation (6). When the checkbox is selected, controls appear for setting the color. Choose a color (7) for the roof-mounted luggage.

9. You could click the **Back** button (1) to return to the **Vehicle: Loaded Condition** screen, then click it again to return to the **CarSim Run Control** screen. However, the **Home** button (2) provides a quicker way to return to the main screen. Click it, and you will return to the most recently viewed Run dataset (shown again in Figure 36).

10. Now that the vehicle dataset is specified, the **Run Math Model** button (1) is active. Click it to make the run.

11. Adjust the settings to overlay the results with the same vehicle without the roof load.

a. Change the run color (3) to red.

b. Change the overlay run. Press the drop-list control (5) for a menu with all existing runs, and choose the run made previously: **My New Test** (6).

12. Click the **Animate** button (2). The animator shows the two selected runs (Figure 37). Although it is possible to see subtle differences (the vehicle with the roof load rolls a little more), this comparison is limited when using the animation as the only visualization tool. Close the animator.

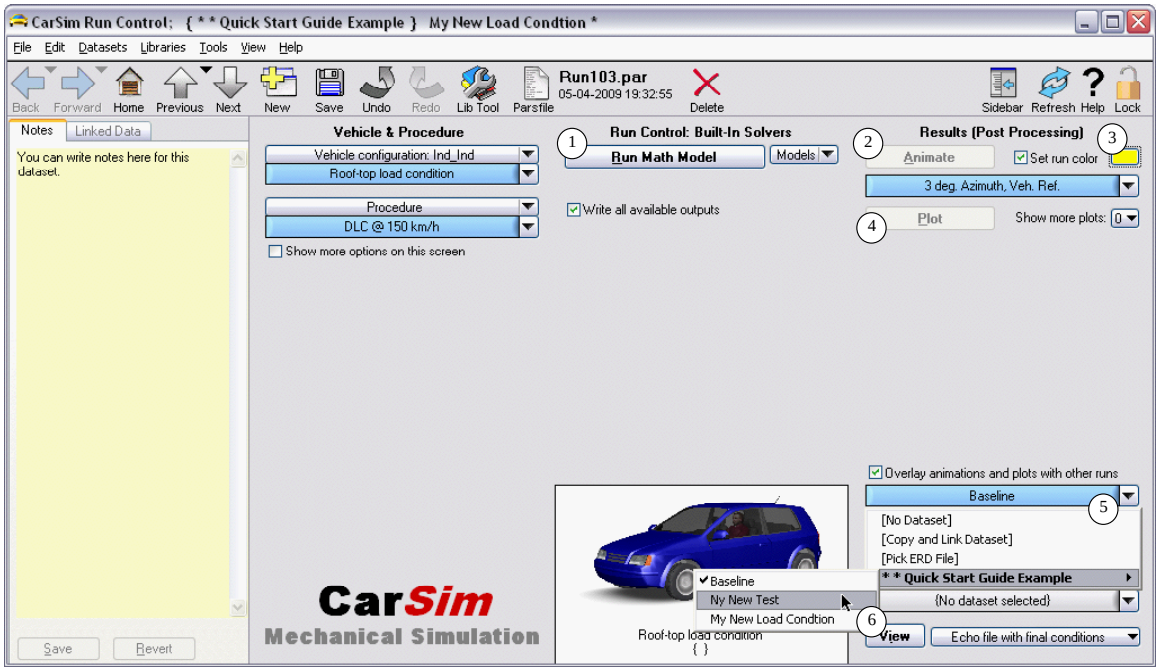


*Figure 36. The **CarSim Run Control** screen, after a new loaded vehicle dataset is specified.*

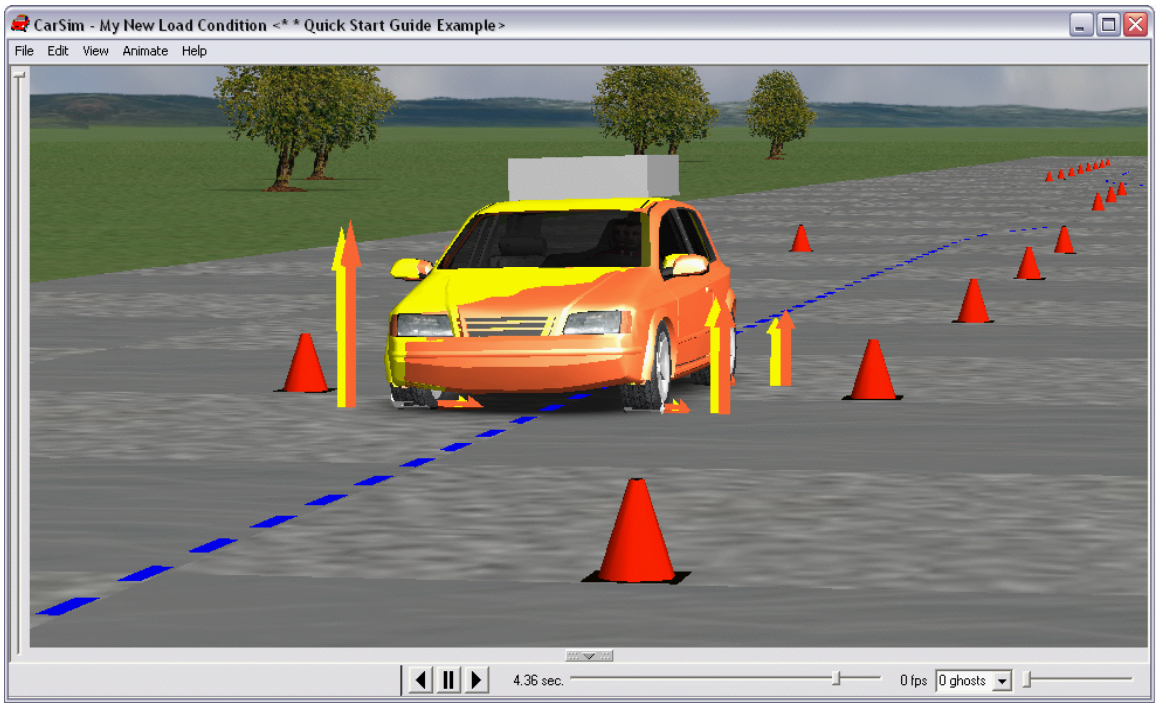


Figure 37. Animation with two vehicle loading conditions overlaid.

13. Click the **Plot** button ④ (Figure 36). The plots also show overlays of results from both runs (Figure 38). These are the sorts of results for which CarSim is often used, in which the

effects of small changes in conditions can be determined quantitatively. Close the plotter when you are through viewing these results.

Review You have changed a linked library (switching from a library of vehicle assemblies to a library of vehicle loading conditions). You then created two datasets from scratch: a payload to represent roof-mounted luggage, and a loaded vehicle condition that combines the baseline vehicle with the roof-mounted luggage.

You have created new datasets from the **CarSim Run Control** screen with the **New** button. You have used the drop-down control next to a blue data link button to **Copy and Link Dataset** to copy an existing dataset; you have also used the same drop-down control to **Link to a New Dataset** to create new datasets from scratch.

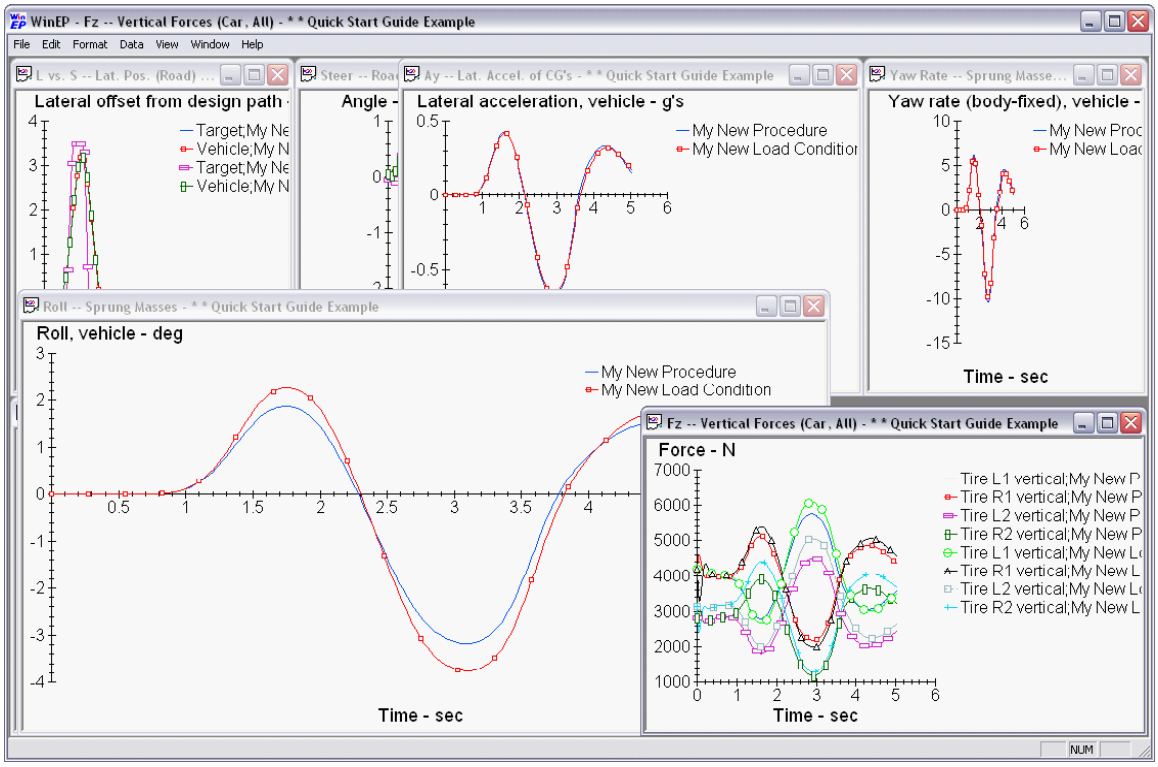


Figure 38. Plots showing sensitivity of vehicle roll and other variables to loading condition.

Run a Vehicle with a Modified Suspension

Continue with the **CarSim Run Control** screen, with the dataset created in the previous section (**Quick Start Guide Example; My New Load Condition** (Figure 39).

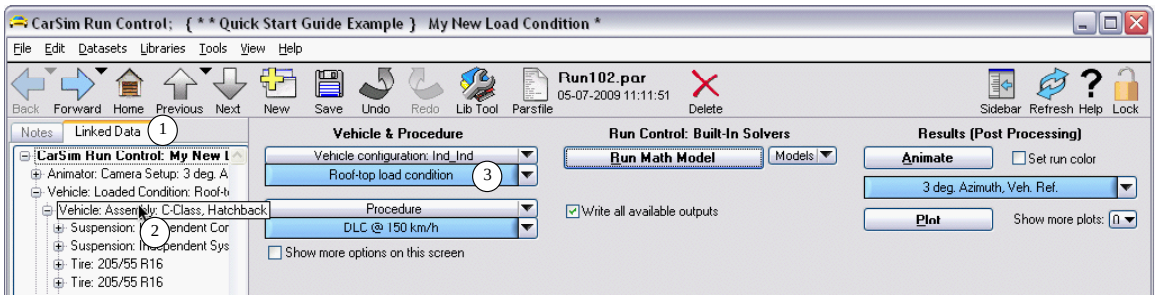


*Figure 39. The **CarSim Run Control** screen with the **Linked Data** sidebar.*

1. Click the **Linked Data** tab in the sidebar on the left (1). This displays an outline "tree" of linked datasets that together provide all of the information about the current run to the vehicle math models, the animator, the plotter, and other parts of CarSim. Notice that the screen currently in view is shown in bold (**CarSim Run Control**). Datasets that in turn have links to other dataset have a control to expand (+) or collapse (-) the view. In the figure, the second item for **Animator: Camera Setup** is collapsed; the third item for **Vehicle Loaded Condition** (2) is expanded.

   Click on the (+) and (-) controls (e.g., (2)) to see the display change. Use the mouse to move the cursor over a name to see the full length. For example, in the figure, the cursor is over the **Vehicle Assembly** dataset and the full title is shown.

2. Click on the blue link button for the loaded vehicle (3) to go to that dataset (Figure 40). Notice that the **Linked Data** display now has the third line highlighted in bold (1), indicating that the **Vehicle: Loaded Condition** screen is in view.

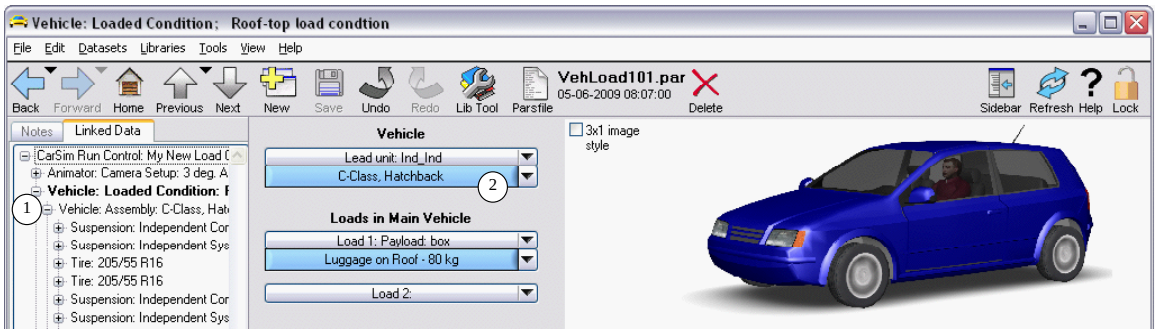


*Figure 40. The **Vehicle: Loaded Condition** screen.*

3. Click on the blue button for the vehicle (2) to go to the vehicle assembly dataset (Figure 41). Notice that the **Linked Data** display now has the fourth line highlighted in bold, indicating that the **Vehicle Assembly** screen is now in view.

4. Click on the suspension rear compliance blue link (2) (Figure 41) to view that dataset (Figure 42). Notice that the **Linked Data** sidebar is updated to show the current dataset in bold.

5. Click on the Auxiliary roll moment blue link (2) (Figure 42) to view that dataset (Figure 43).

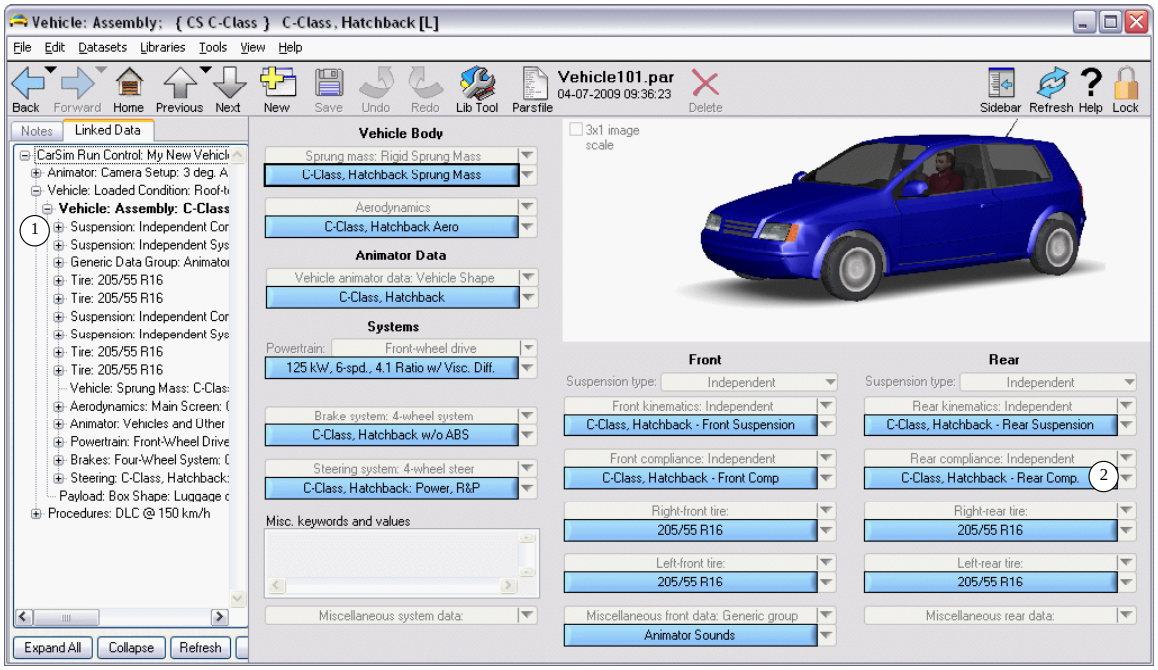


*Figure 41. The **Vehicle Assembly** screen.*

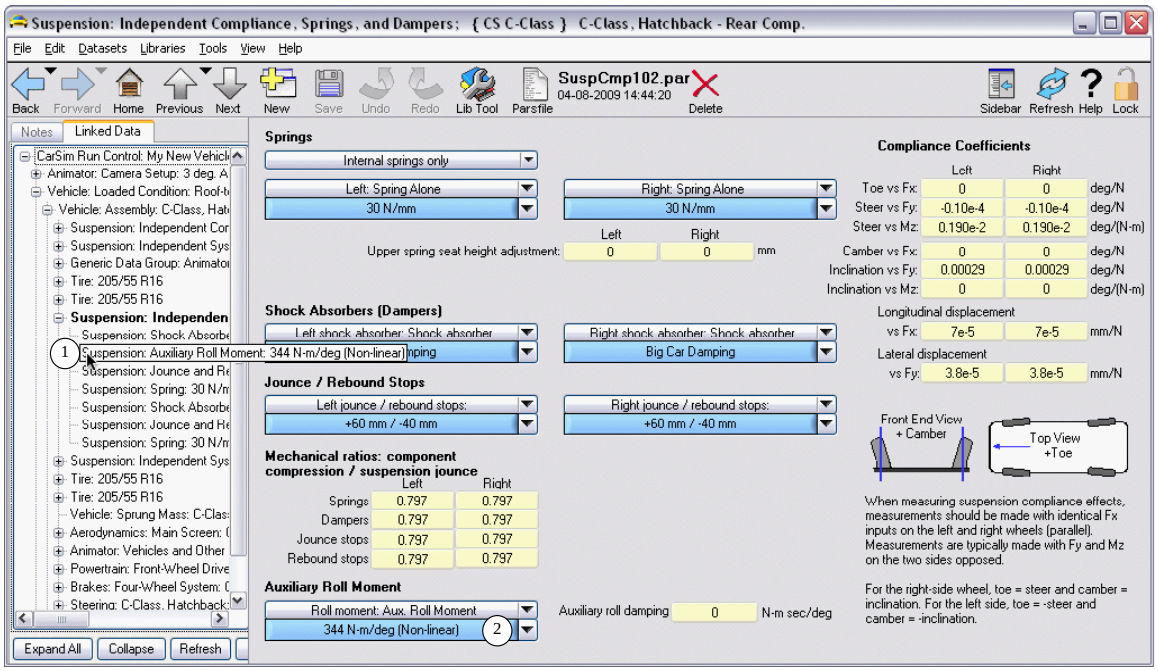


Figure 42. Suspension compliance screen.

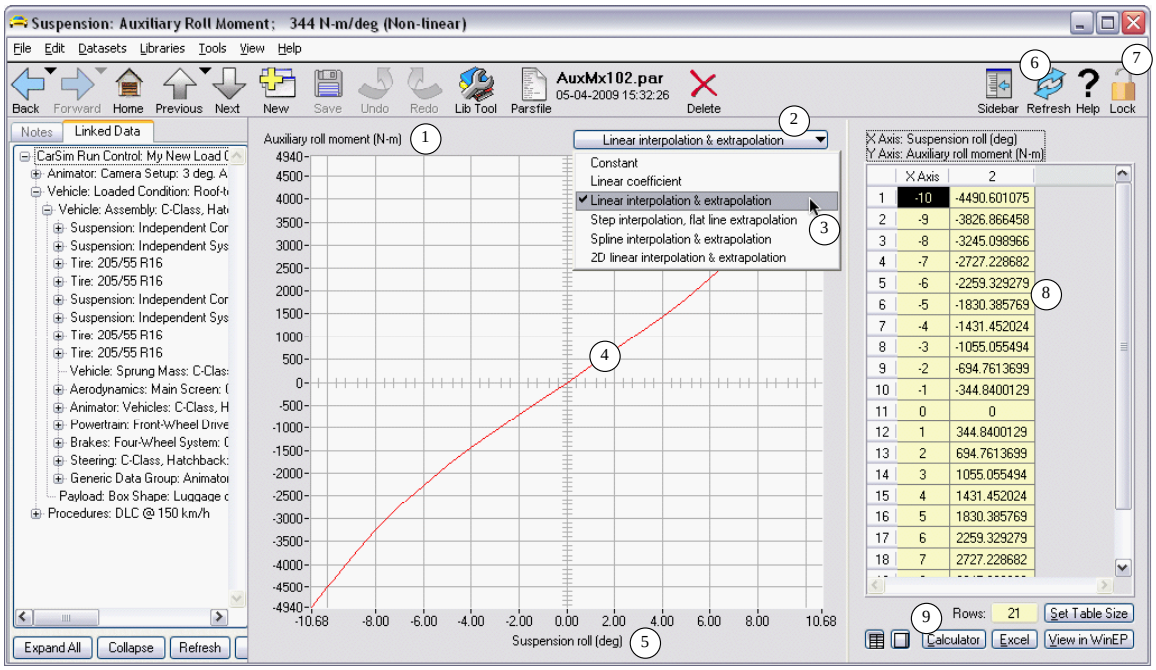


Figure 43. Nonlinear table for the auxiliary roll moment.

This part of the vehicle math model represents roll resistance in the suspension in addition to the effect of the suspension springs. It is due to anti-sway bars and binding of suspension linkages (which adds stiffness) and compliance of sheet metal and suspension parts (which adds compliance). Suppose we want to see how increasing this stiffness will affect the roll behavior during the double lane-change maneuver.

This screen is similar to many others in CarSim that show a potentially nonlinear relationship between two or three measurable variables. In this case, the table defines auxiliary roll moment (1) as a variable that is dependent on the suspension roll angle (5). The relationship is shown graphically (4), and the numbers used to define the relationship are shown in a spreadsheet (8).

If the dataset is locked, click the **Lock** button (7) to unlock it.

CarSim supports alternative methods for calculating the dependent variable. Click the drop-list control (2) to see the calculation methods (3). The roll moment could be a constant (e.g., zero), a linear coefficient, calculated using linear or spline interpolation, etc.

6. Use the drop-list control (2) to change the calculation method. Select each option on the list and view the new display to see how the table is interpreted.

Two things to note:

a. The screen immediately updates to show the new representation. If a constant or linear coefficient is selected, the graph and spreadsheet disappear to show a single yellow field with the parameter (Figure 44). If a spline is selected, the data points are shown together with the curved spline. If a 2D table is chosen, the label on the

spreadsheet is extended and you can add multiple columns to support data obtained for different static load conditions.

b. As soon as any change is made, the title of the window is modified with a '*' suffix ①. This is a visual indicator that you have modified the dataset.

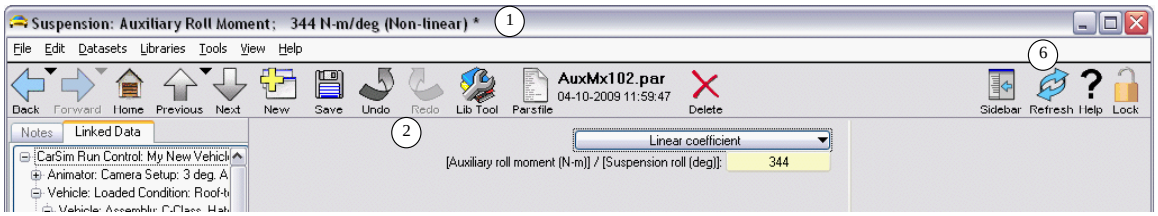


Figure 44. Auxiliary roll moment using a linear coefficient.

7. Use the Undo button ② to revert the dataset back to its original state. Keep clicking until the '*' suffix disappears from the window title. The screen should once again look like it did in Figure 43.

8. Make a new dataset with the same shape for the nonlinear relationship, but with twice the stiffness.

a. Click the **New** button and give the new dataset the title 688 N-m/deg (Non-linear).

b. Click the **Calculator** button ⑨ (Figure 43) to bring up the CarSim calculator tool for tabular data (Figure 45).

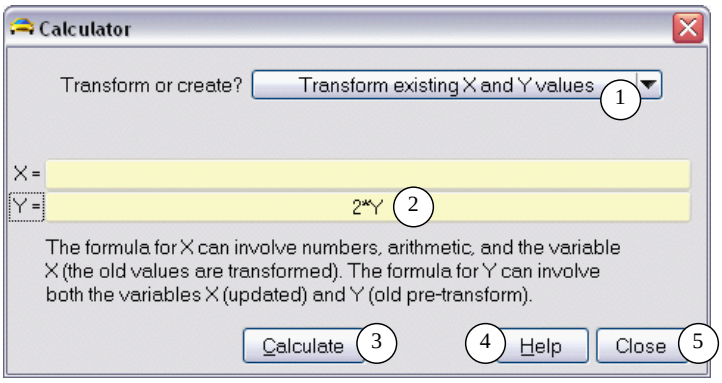


Figure 45. The calculator tool for tabular data.

c. Set the drop-down list for the option **Transform existing X and Y values** ①.

d. To double the values of the dependent variable, type 2*Y as shown ②.

e. Click the **Calculate** button ③. You should see an immediate change in the graphic in the data window in the background.

f. Notice that there is a **Help** button ④. Later on, you can use this to view documentation that describes more of the capabilities of this calculator.

g. Click the **Close** button ⑤. Click the **Refresh** button ⑥ on the data screen to force a refresh of the plotted data (Figure 46).

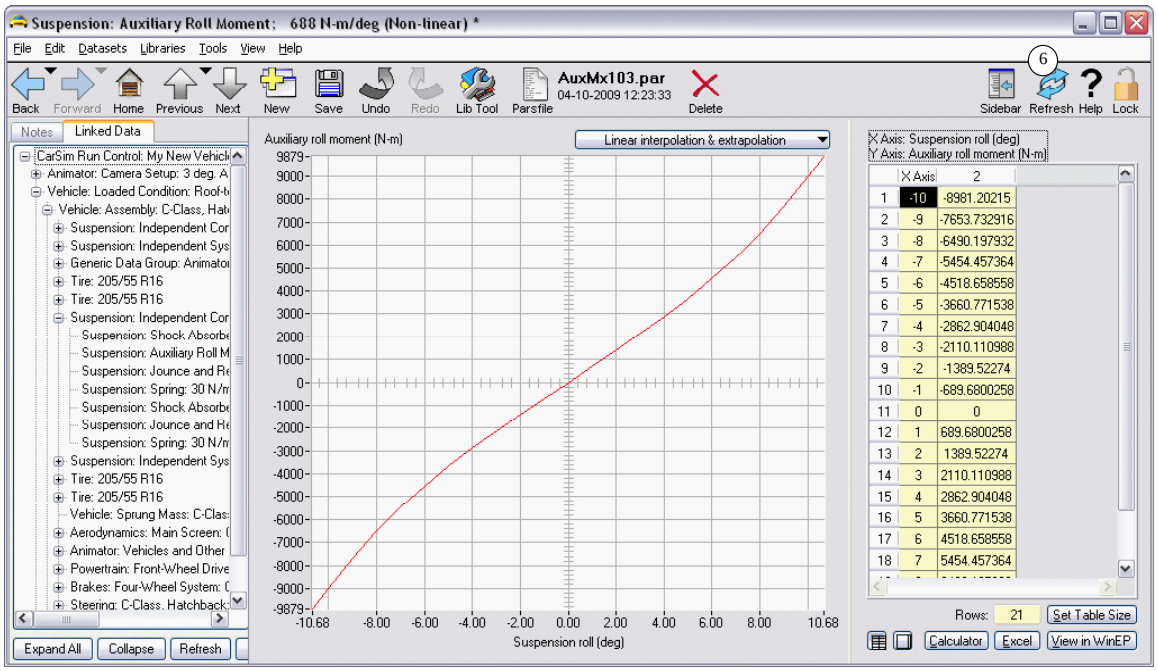


Figure 46. New dataset with doubled roll stiffness.

Notice that the **Linked Data** sidebar no longer shows a dataset in bold. You have created a new dataset here, but it is not yet associated with the original run named **My New Vehicle**.

Before you can simulate a vehicle that uses this new auxiliary roll moment dataset, you will make some new datasets. You need:

a. a new suspension dataset that uses this auxiliary roll moment,

b. a new vehicle assembly that uses the new suspension,

c. a new vehicle loaded condition that uses the new vehicle assembly, and

d. a new test that uses the new vehicle loaded condition.

You will continue with the general method you have used previously to make new datasets.

a. You will use a drop-down control for a linked dataset and choose the option to **Copy and Link Dataset**.

b. CarSim will copy the dataset and prompt you to provide a title for the new copy.

c. You will click on the blue link button to view the new dataset and edit it.

9. Click the **Home** button to return to the **CarSim Run Control** screen. The run title is **My New Load Condition** (Figure 39).

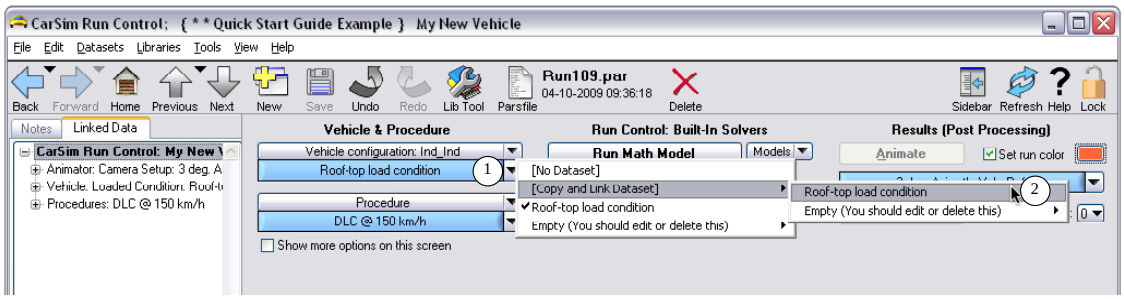


*Figure 47. The **CarSim Run Control** screen with a new title but no new data.*

10. Make a new dataset and give it the name My New Vehicle (Figure 47). As before, the screen shows your new title, and the **Animate** and **Plot** buttons are dimmed because the run hasn't been made yet. Select a color for the run.

11. Use the drop-down control (1) for the linked vehicle dataset and choose the option to **Copy and Link Dataset**. Name it Roof-top load, double roll stiffness. Click the blue button to go to the new dataset (Figure 48).

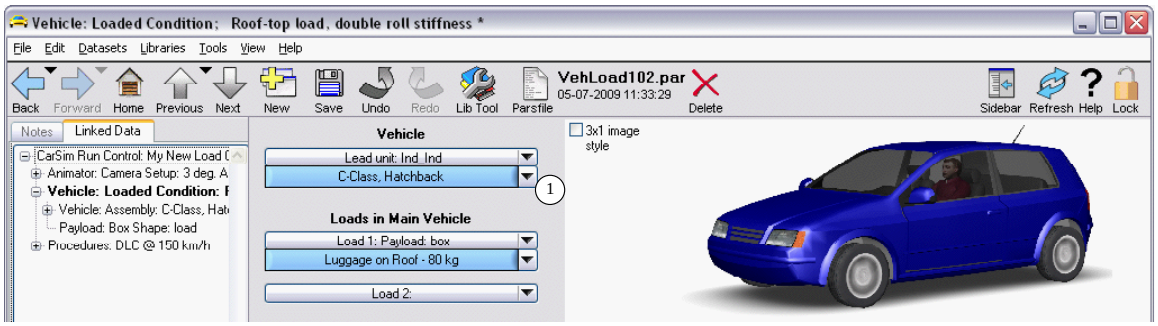


Figure 48. New vehicle load condition that will use a new vehicle.

12. Use the drop-down control (1) (Figure 48) for the linked vehicle dataset and choose the option to **Copy and Link Dataset**. Name it My New Vehicle. Click the blue button to go to the new dataset (Figure 49).

13. Use the drop-down control (1) (Figure 49) for the linked suspension compliance dataset and choose the option to **Copy and Link Dataset**. Name it My New Suspension. Click the blue button to go to the new dataset (Figure 50).

14. Use the drop-down control (3) for the linked auxiliary roll moment dataset and choose the dataset you created in step 8: **688 N-m/deg (Non-linear)**.

15. Click the **Refresh** button (2) at the bottom of the **Linked Data** sidebar. If needed click the (+) buttons to expand the view of the vehicle datasets. The new datasets should appear in the list, with the current one (**My New Suspension)** shown in bold. (If your display is limited in width as in the figure, you must move the mouse over the bold **Vehicle: Assembly** item to see the title of the dataset.)

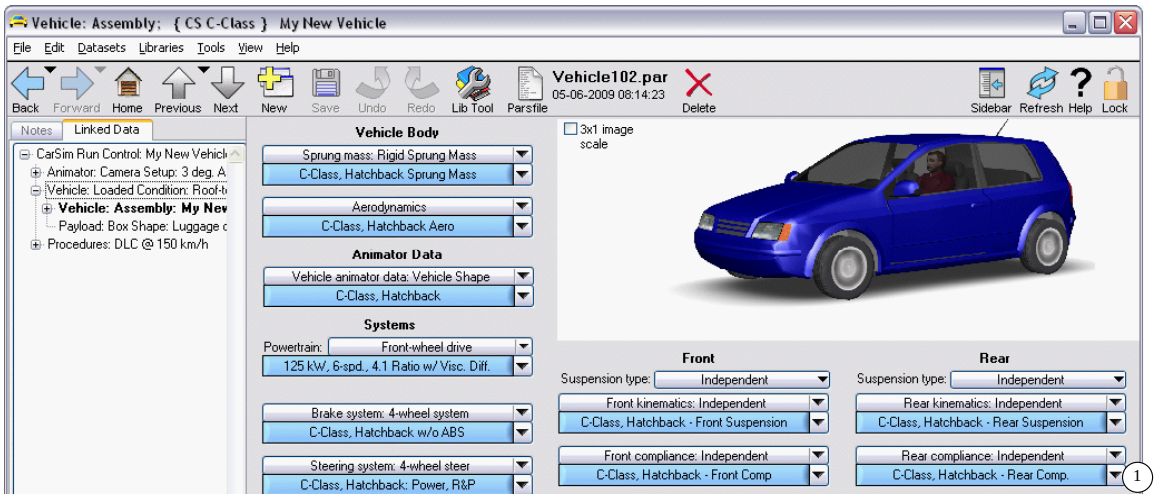


Figure 49. New vehicle that will use the new rear suspension.

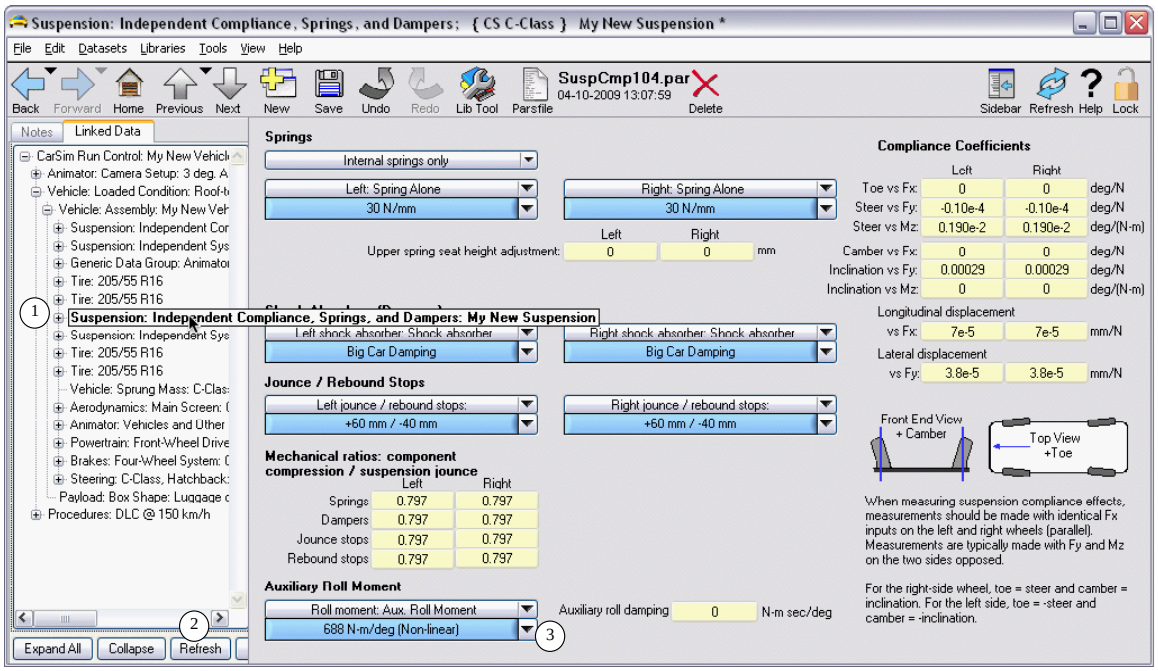


Figure 50. Suspension screen connected to new auxiliary roll moment dataset.

16. Double-click the first line in the **Linked Data** sidebar to return to the home screen (Figure 47).

17. Run the new vehicle by clicking the **Run Math Model** button.

18. In the lower-right region of the **CarSim Run Control** screen (Figure 51), use the drop-down list for the overlay run link to change to the run **My New Load Condition** (the run made in the previous section).

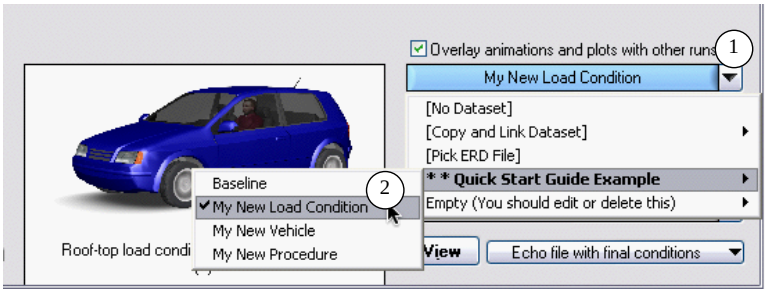


Figure 51. Change the overlay run.

19. Click the **Plot** button to compare the behavior of the new vehicle with the original. As expected, the modified vehicle has less roll angle (Figure 52). Close the plotter when you are through viewing these results.

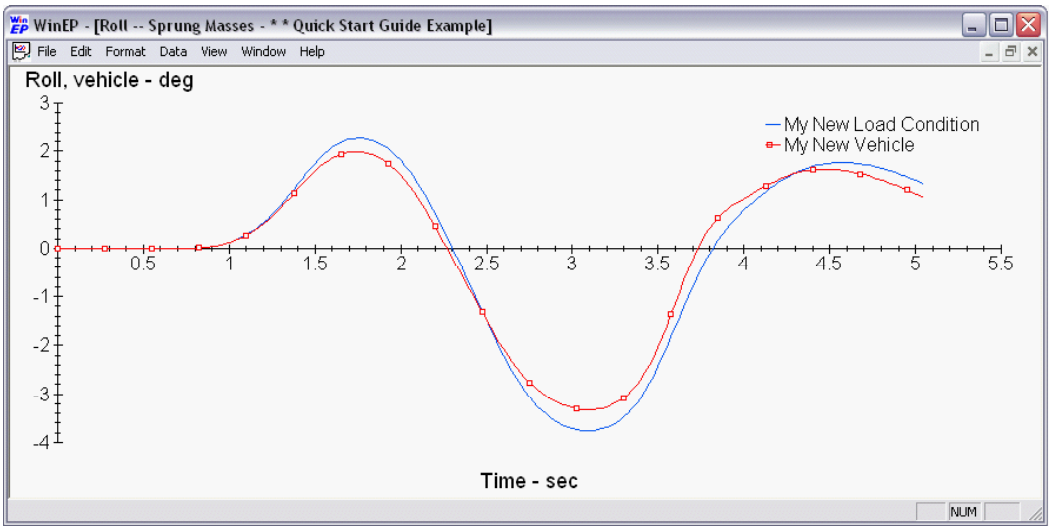


Figure 52. Comparison of roll angle for original and modified vehicle.

Review You have now made more new datasets that test the effect of a major change in the roll stiffness of the rear suspension.

In doing this, you have worked with a CarSim tabular dataset, and used the built-in calculator to transform existing data.

You have seen the general organization of the datasets in CarSim. The description sent to the math model or animator is built from dataset parts that in turn are assembled from more dataset parts. The main screen might have just two links: one for the vehicle and one for the procedure (Figure 53). The vehicle datasets are in turn assembled from component datasets. In this section, you modified one of those components; with more experience, you will use the same methods to modify many others.

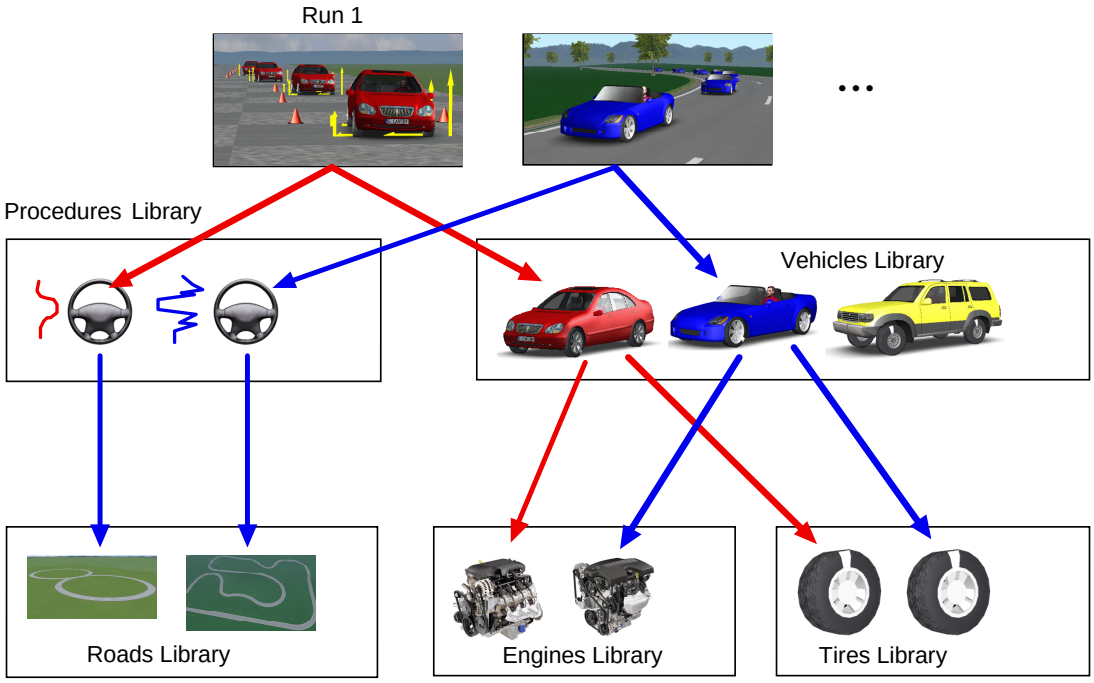


Figure 53. Simulation runs are assembled from datasets selected from libraries.

Make a New CarSim Desktop Shortcut

You will conclude this chapter by creating a new desktop shortcut for the database you created, to simplify your return in the next chapter.

1. Select the **Tools** menu item **Create Shortcut to this Database**. CarSim will prompt you to give the shortcut a name and location. For example, call it `My CarSim QS shortcut` and locate it on your desktop.
2. Exit CarSim.

   Depending on your Windows settings and selected location in step 1, you might see the shortcut with the CarSim icon on your desktop:

Review You have concluded the basic CarSim tutorial and covered the basics of using the software. The shortcut you just created can be used in the future to return to this example database.

3. More CarSim Features

You have covered the basics of working with CarSim in the previous chapter. You used the animator and plotter, added new datasets to define new procedures and vehicle properties, and used simulations to show the effects of variations in vehicle load and suspension properties.

In this chapter, you will build on that experience and see a few more CarSim features.

Restart CarSim

You will continue from the same CarSim session that was started in Chapter 2.

The last action taken in Chapter 2 was to create a shortcut to the database; if you did this, then you can double-click that shortcut to return to the quick-start database.

> **Option** If you don't like using desktop shortcuts, you can start CarSim as before (e.g., use the Windows **Start** menu). When prompted to choose a database (see Figure 1 on page 6), select the quick-start database that you created earlier, and then click the button **Continue with the selected database**.

Get More Information

During the tutorial in Chapter 2, you right-clicked buttons and saw pop-up information. You also used the **Help** menu and **Help** button to see information about the currently displayed data screen.

Much more information is available on-line in the **Help** menu. It provides reference information for all menus, controls, and screens (Figure 54). There are also technical memos that show by example some of the more advanced features in CarSim.

All of the documentation has been indexed to provide a rapid search capability. The second item on the **Help** menu is **Search Help**. Select this item to bring up a search Window (Figure 55) from your installed PDF browser (typically Adobe Reader). In the figure, the index file is identified as `CarSim_Help.pdx` ② and the example search phrase is "tire model" ①. Click the **Search** button to bring up all occurrences of the phrase (Figure 56), and double click on any results to view that occurrence in your PDF viewer.

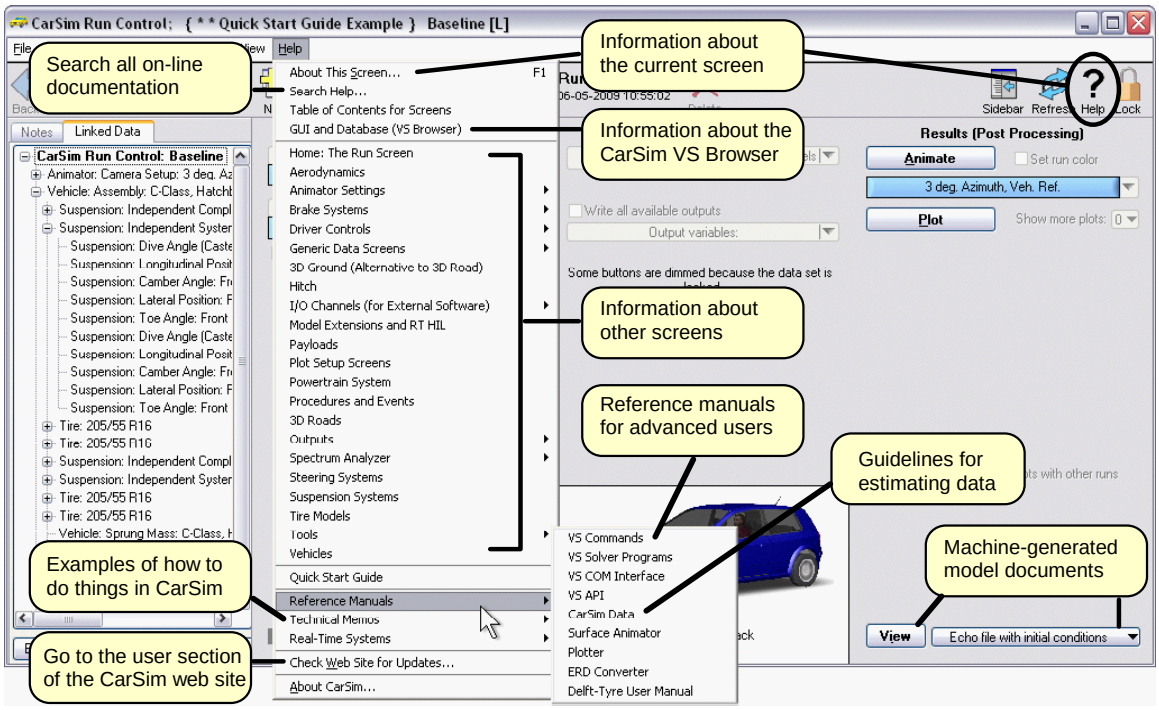


*Figure 54. On-line information available from the Help menu and **View** button.*

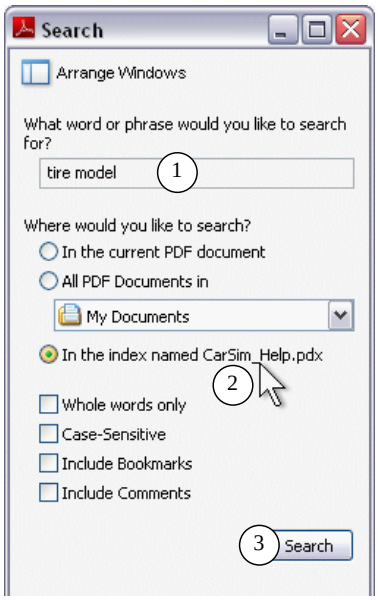


*Figure 55. The Search window for PDF files (access with the **Help** menu item **Search Help**).*

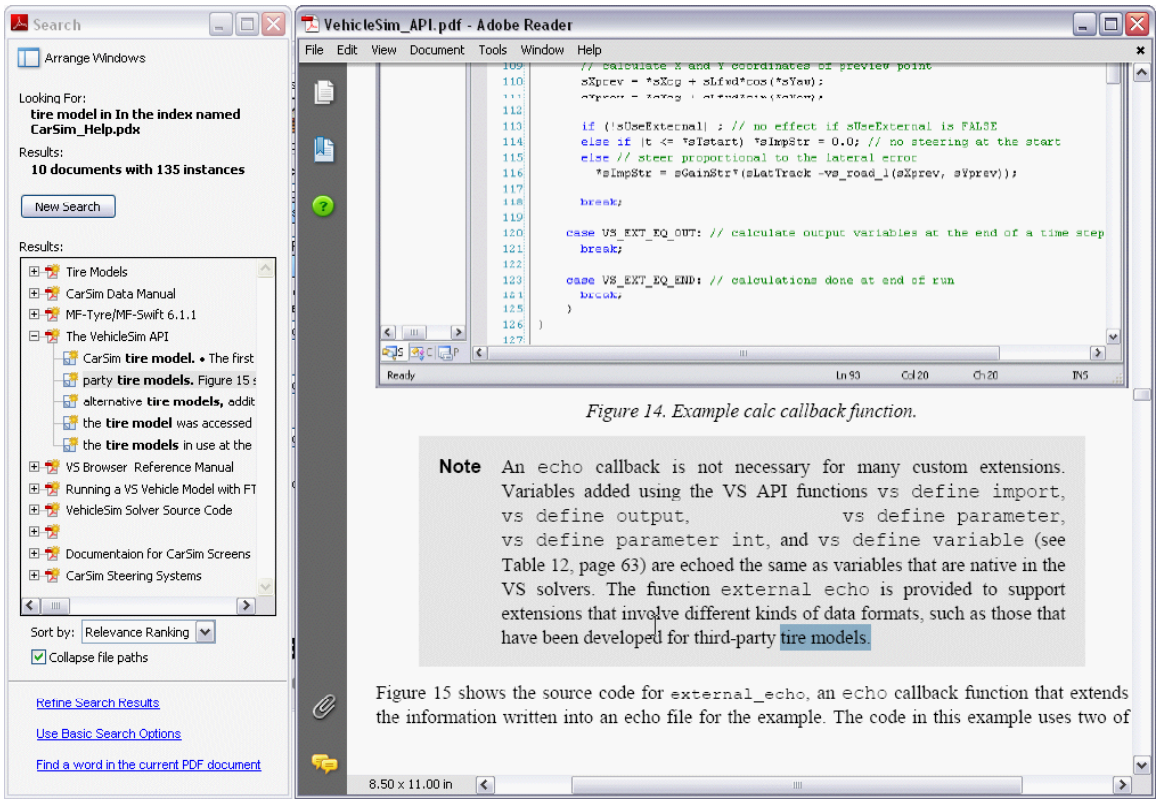


Figure 56. Results of search for a phrase in the CarSim documentation.

On the **CarSim Run Control** screen, there is a **View** button ① (Figure 57) in the lower-right corner of the screen that provides access to a number of machine-generated documents that describe technical details about the math models.

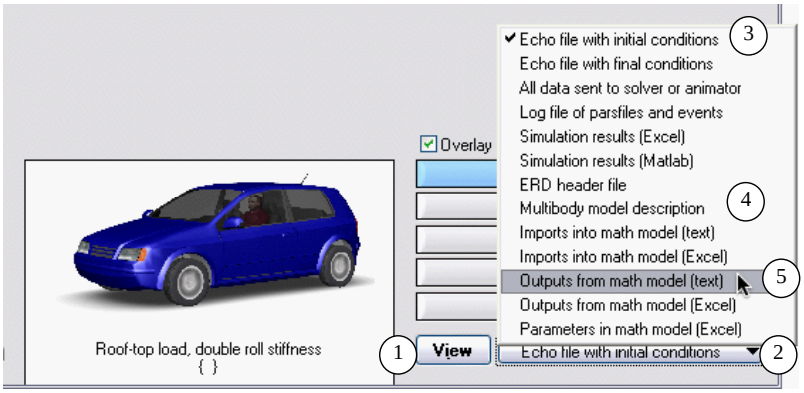


*Figure 57. View button in the lower-right corner of the **CarSim Run Control** screen.*

1. Use the drop-down list ② next to the **View** button and select the first item **Echo file with initial conditions** ③. Just selecting the file should display text in an editor (Figure 58). If the text editor does not appear, it might be necessary to also click the **View** button.

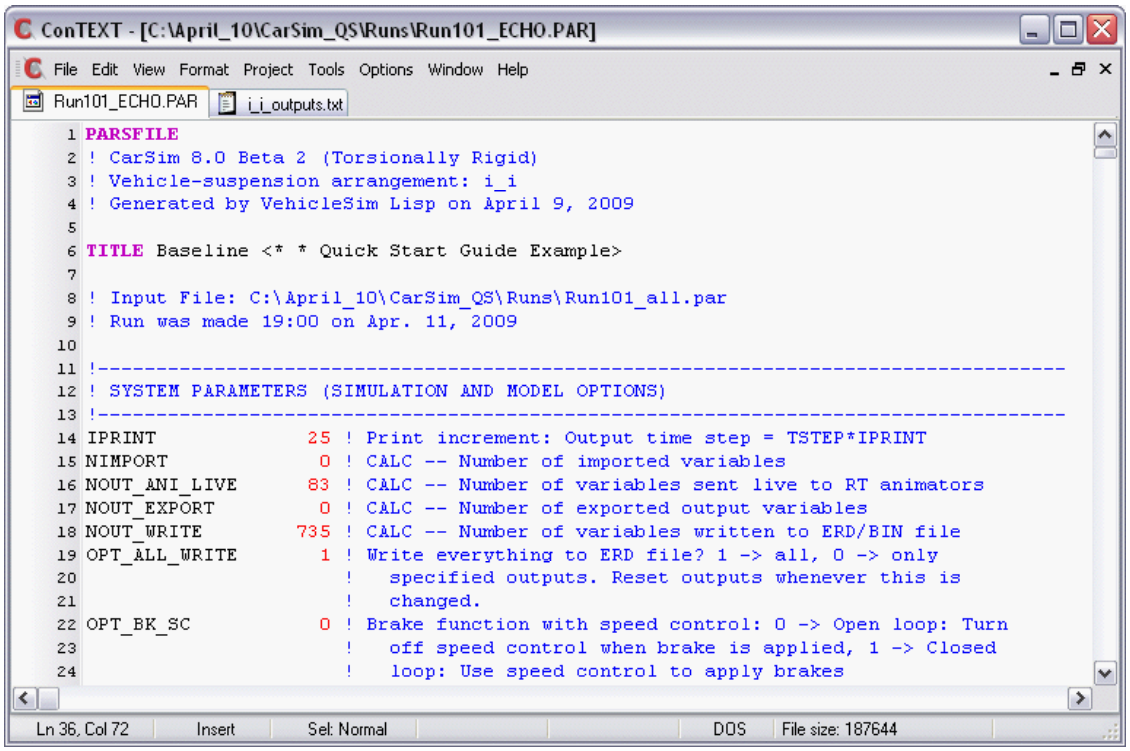


Figure 58. Echo file generated for a simulation run.

2. Scroll through this echo file in the editor. Note that it is organized in several sections, going from top to bottom:

   a. The top of the file has system parameters that exist in any CarSim model such as the time step, start time, stop time, etc. The format of the file is described in the reference manual for VS commands and the solver programs, accessed from the **Help** menu (Figure 54). The parameters are listed in alphabetical order.

   b. The next section has model-specific parameters (dimensions, masses, coefficients, etc.). They are also listed in alphabetical order.

   c. The file next lists all of the tabular data, such as the auxiliary roll moment table that was used in the tutorial. The tables are also presented alphabetically.

3. Use the drop-down list (2) next to the **View** button and select the item **Outputs from math model (text)** (5) (Figure 57). The text file should appear in the editor (Figure 59). The variables are listed in alphabetical order, based on the unique short names (eight-character limit) associated with each variable.

4. Use the search feature in the text editor to search for `auxiliary roll`. (Use the **Edit** menu item **Find** or type Ctrl-F to bring up the search dialog box.) You should find that there are two variables available as outputs: `Mx_A1` and `Mx_A2`, the roll moments for axles 1 and 2. The fact that they exist means they can be plotted, as you will do shortly.

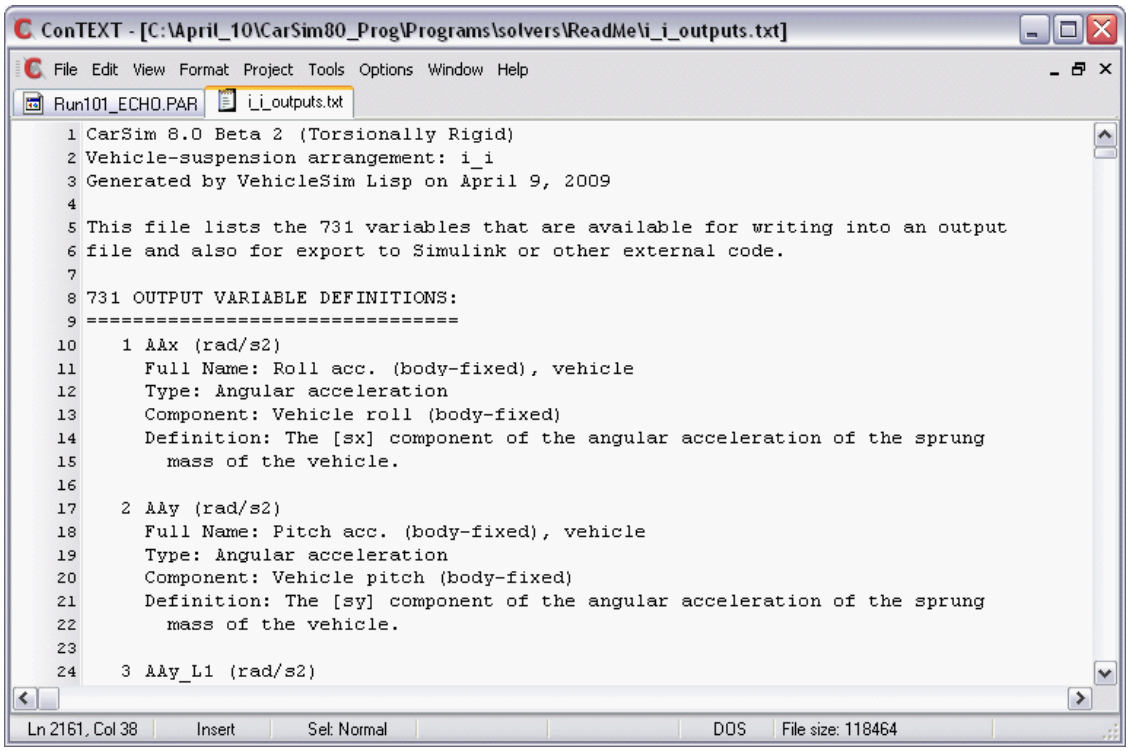
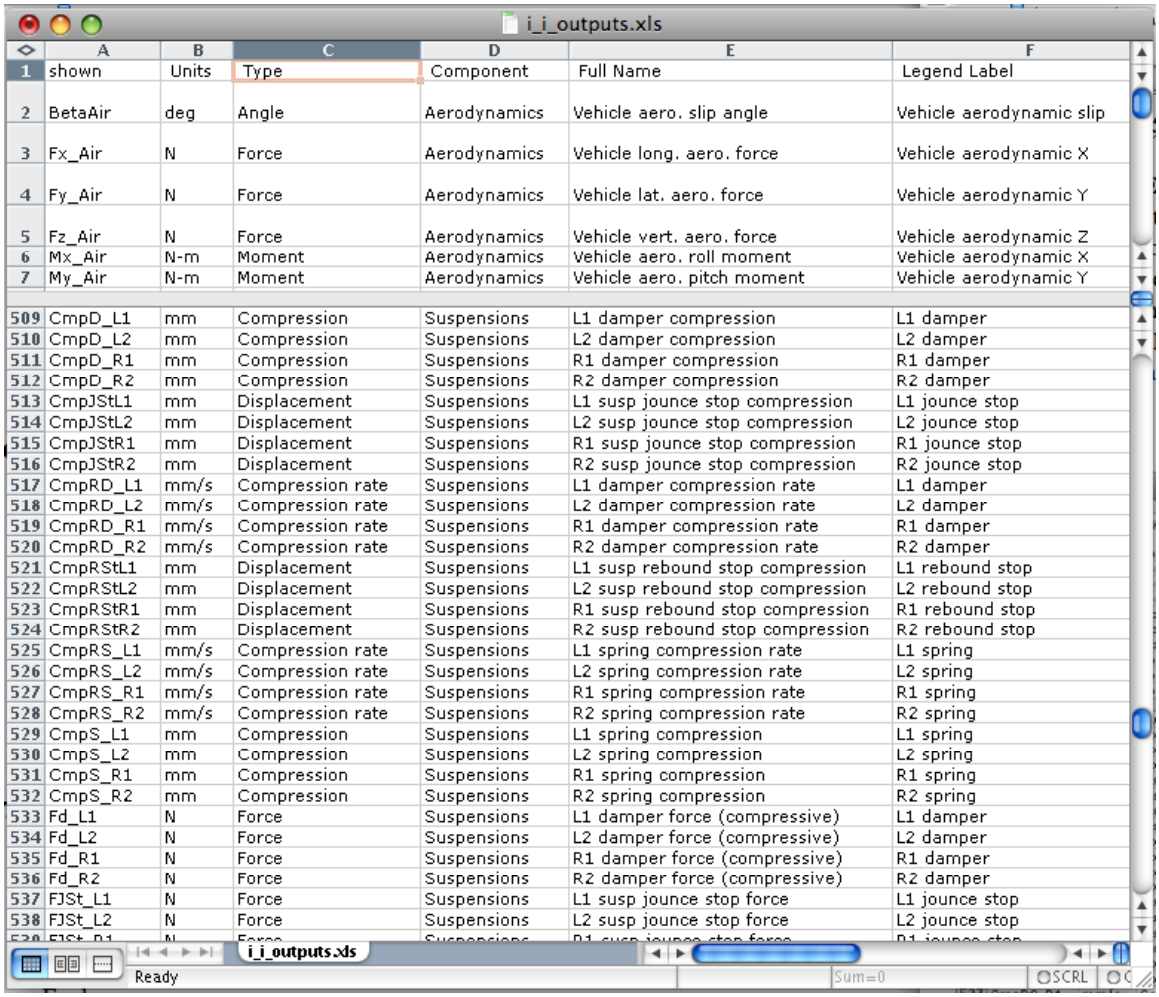


Figure 59. Text file listing all output variables available from a math model.

5. If you have Excel or another spreadsheet program on your computer, then use the drop-down list ② next to the **View** button (Figure 57) to select the item **Outputs from math model (Excel)**. The same information shown before in a text file is now shown in a spreadsheet. The original sequence is in alphabetical order, as with the text version. However, the spreadsheet includes other labels such as component, units, type, and can be sorted using any of those alternate labels. For example, Figure 60 shows the names of the output variables sorted by component. The figure shows how all variables related to suspension are grouped together, making it easier to find the names of all suspension-related variables available for plotting.

Close the spreadsheet when you are through browsing the output variable names.



i_i_outputs.xls

	A	B	C	D	E	F
1	shown	Units	Type	Component	Full Name	Legend Label
2	BetaAir	deg	Angle	Aerodynamics	Vehicle aero. slip angle	Vehicle aerodynamic slip
3	Fx_Air	N	Force	Aerodynamics	Vehicle long. aero. force	Vehicle aerodynamic X
4	Fy_Air	N	Force	Aerodynamics	Vehicle lat. aero. force	Vehicle aerodynamic Y
5	Fz_Air	N	Force	Aerodynamics	Vehicle vert. aero. force	Vehicle aerodynamic Z
6	Mx_Air	N-m	Moment	Aerodynamics	Vehicle aero. roll moment	Vehicle aerodynamic X
7	My_Air	N-m	Moment	Aerodynamics	Vehicle aero. pitch moment	Vehicle aerodynamic Y
509	CmpD_L1	mm	Compression	Suspensions	L1 damper compression	L1 damper
510	CmpD_L2	mm	Compression	Suspensions	L2 damper compression	L2 damper
511	CmpD_R1	mm	Compression	Suspensions	R1 damper compression	R1 damper
512	CmpD_R2	mm	Compression	Suspensions	R2 damper compression	R2 damper
513	CmpJStL1	mm	Displacement	Suspensions	L1 susp jounce stop compression	L1 jounce stop
514	CmpJStL2	mm	Displacement	Suspensions	L2 susp jounce stop compression	L2 jounce stop
515	CmpJStR1	mm	Displacement	Suspensions	R1 susp jounce stop compression	R1 jounce stop
516	CmpJStR2	mm	Displacement	Suspensions	R2 susp jounce stop compression	R2 jounce stop
517	CmpRD_L1	mm/s	Compression rate	Suspensions	L1 damper compression rate	L1 damper
518	CmpRD_L2	mm/s	Compression rate	Suspensions	L2 damper compression rate	L2 damper
519	CmpRD_R1	mm/s	Compression rate	Suspensions	R1 damper compression rate	R1 damper
520	CmpRD_R2	mm/s	Compression rate	Suspensions	R2 damper compression rate	R2 damper
521	CmpRStL1	mm	Displacement	Suspensions	L1 susp rebound stop compression	L1 rebound stop
522	CmpRStL2	mm	Displacement	Suspensions	L2 susp rebound stop compression	L2 rebound stop
523	CmpRStR1	mm	Displacement	Suspensions	R1 susp rebound stop compression	R1 rebound stop
524	CmpRStR2	mm	Displacement	Suspensions	R2 susp rebound stop compression	R2 rebound stop
525	CmpRS_L1	mm/s	Compression rate	Suspensions	L1 spring compression rate	L1 spring
526	CmpRS_L2	mm/s	Compression rate	Suspensions	L2 spring compression rate	L2 spring
527	CmpRS_R1	mm/s	Compression rate	Suspensions	R1 spring compression rate	R1 spring
528	CmpRS_R2	mm/s	Compression rate	Suspensions	R2 spring compression rate	R2 spring
529	CmpS_L1	mm	Compression	Suspensions	L1 spring compression	L1 spring
530	CmpS_L2	mm	Compression	Suspensions	L2 spring compression	L2 spring
531	CmpS_R1	mm	Compression	Suspensions	R1 spring compression	R1 spring
532	CmpS_R2	mm	Compression	Suspensions	R2 spring compression	R2 spring
533	Fd_L1	N	Force	Suspensions	L1 damper force (compressive)	L1 damper
534	Fd_L2	N	Force	Suspensions	L2 damper force (compressive)	L2 damper
535	Fd_R1	N	Force	Suspensions	R1 damper force (compressive)	R1 damper
536	Fd_R2	N	Force	Suspensions	R2 damper force (compressive)	R2 damper
537	FJSt_L1	N	Force	Suspensions	L1 susp jounce stop force	L1 jounce stop
538	FJSt_L2	N	Force	Suspensions	L2 susp jounce stop force	L2 jounce stop

Figure 60. Spreadsheet showing output variables available from a math model.

6. Use the drop-down list ② (Figure 57) to select the item **Multibody model description** ④. This brings up a description of the math model, listing all degrees of freedom, forces, and moments.

When you are through viewing the text files, close the text editor.

7. If you have Internet access, try the web link near the bottom of the **Help** menu: **Check web site for updates**. If you have not visited this part of the CarSim site before, you will be prompted for a password (Figure 61).

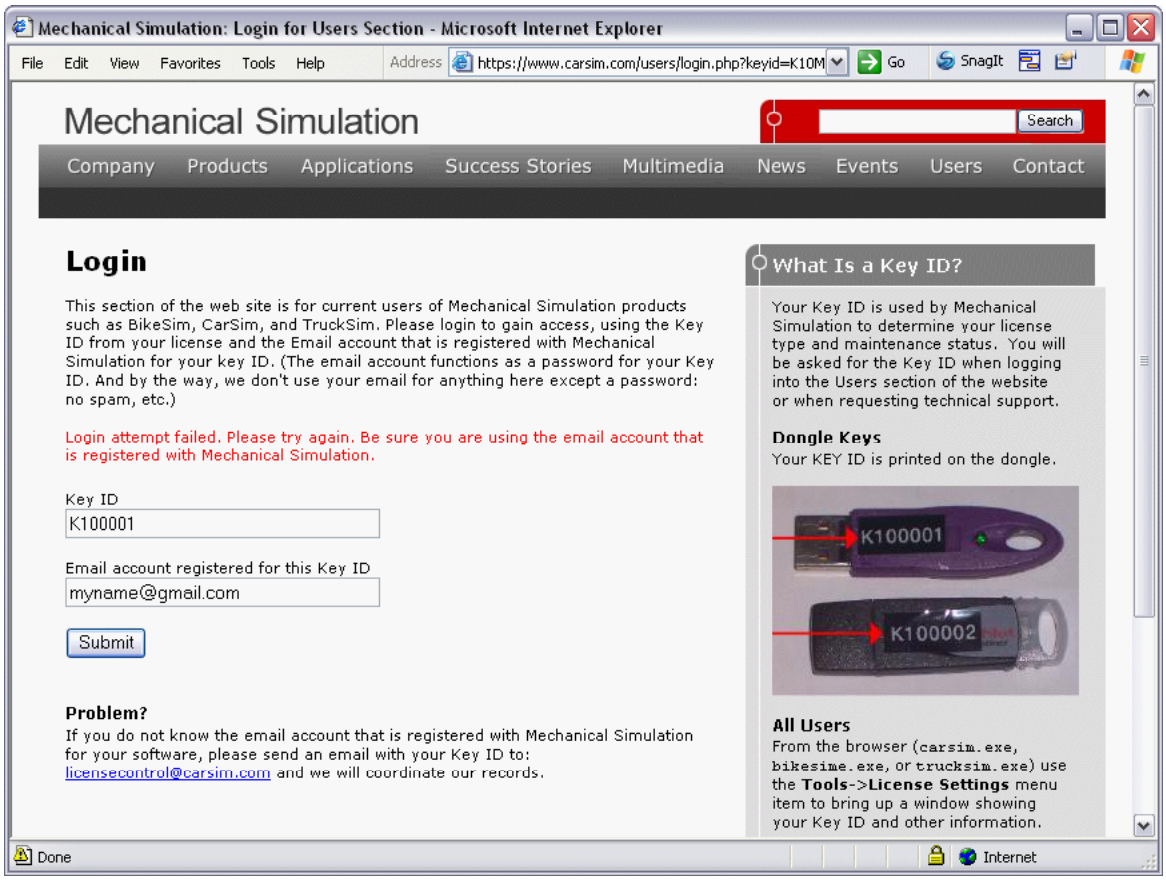


Figure 61. Login to user section of web site.

CarSim will automatically enter the key ID, so you just have to enter your email address.

Note Your email is used on the web site only as a password: it is not saved or recorded. (Be aware that it will only work if it is listed in the Mechanical Simulation license database with your other license information. If it doesn't work, contact Mechanical Simulation; send an email to licensecontrol@carsim.com with your key ID and contact information.) Generally, the email is initially set for the person who bought the software.

Once logged in, you will see the user section (Figure 62). This section has backup copies of the software, updates, bug reports, fixes, and other resources that are added as part of normal maintenance.

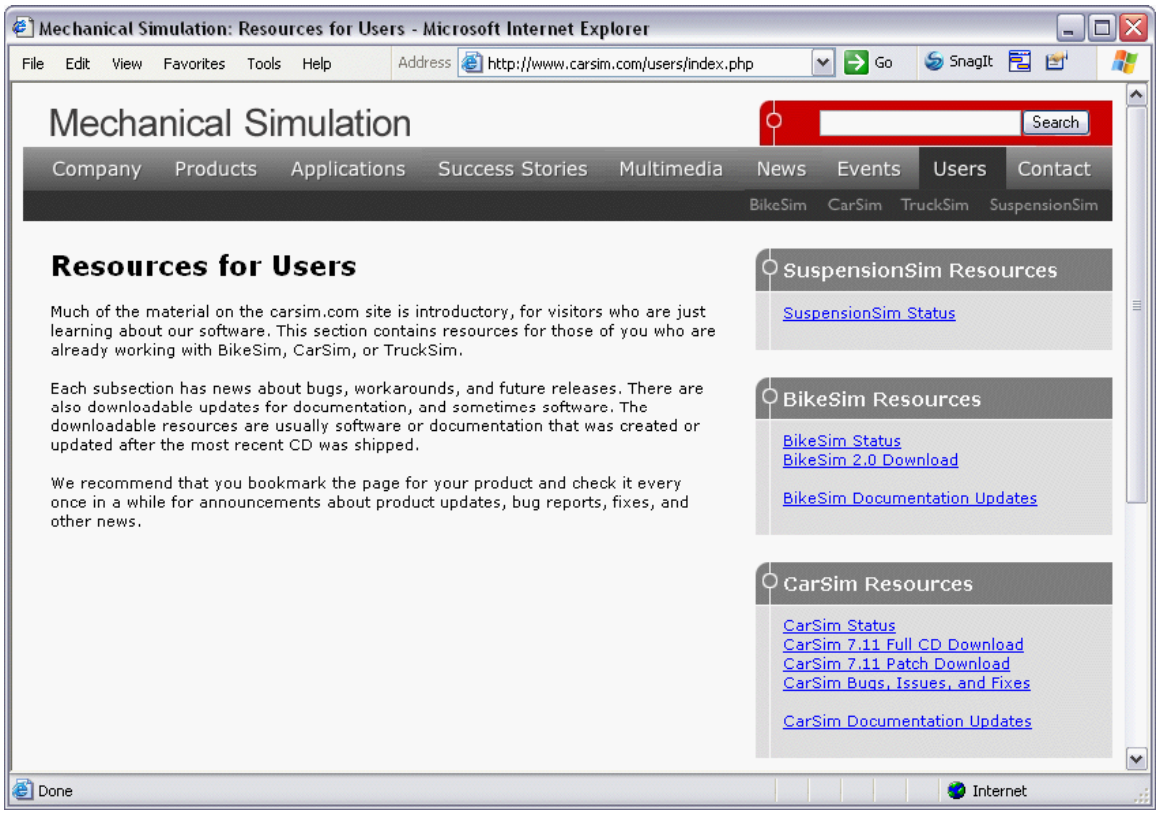


Figure 62. Users section of the CarSim web site.

Review As you are learning about CarSim, you will first focus on getting through this Quick Start guide. Later on, when you're ready for more advanced features, you can get more information. The main resources are the **Help** menu, the **View** button on the main screen, and the users section of the web site: www.carsim.com/users

In going through the list of available output variables, we saw that the auxiliary roll moment is produced by the math model. In the next section, we will see how to make custom plot setups to view additional variables such as these roll moments.

Make New Plots

Continue with the **CarSim Run Control** screen, with the last dataset that was created in Chapter 2 (**Quick Start Guide Example; My New Vehicle** (Figure 63)).

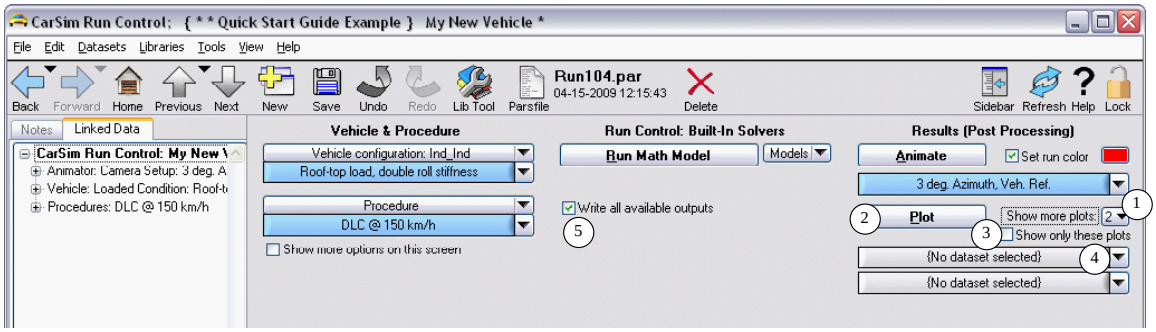


*Figure 63. Adding more plots from the **CarSim Run Control** screen.*

1. Use the drop-down control ① to show more plots. (Specify 2, as shown in the figure.)
2. Use the drop-down control ④ for the first plot dataset and select the option to **Link to New Dataset**. Name it My New Plot. Click the blue link button to view it (Figure 64).

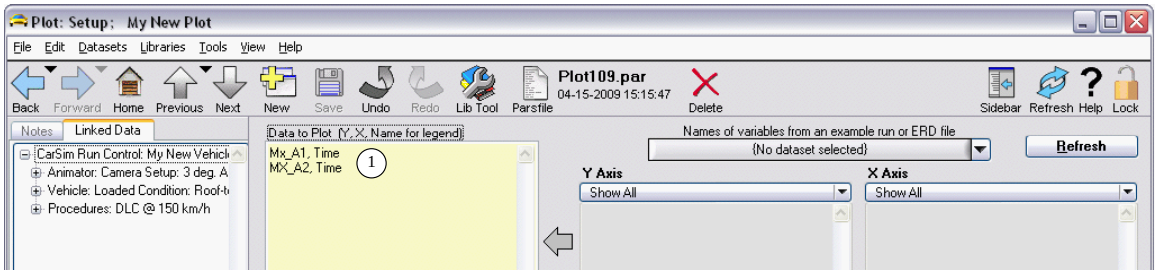


Figure 64. Dataset to define new plot.

3. Type two lines into the yellow field labeled **Data to Plot** as shown ①: Mx_A1, Time and Mx_A2, Time

> **Note** Each line of text in the **Data to Plot** field should specify two variable names separated by a comma, with the variable on the vertical axis being named first. Recall that when you searched files listing all output variables in the previous section (page 44), the names of the roll moments were `Mx_A1` and `Mx_A2`.

4. Click the **Back** button or **Home** button to return to the **CarSim Run Control** screen**.**
5. Click the **Plot** button**.** The plotter shows all of the plots seen before, plus the new one. You can change the settings to view only the newly defined plot.

   Close the plotter.
6. Check the box to **Show only these plots** ③ (Figure 63) and then click the **Plot** button again. This time, only one plot window appears (Figure 65). After viewing, close the plotter.

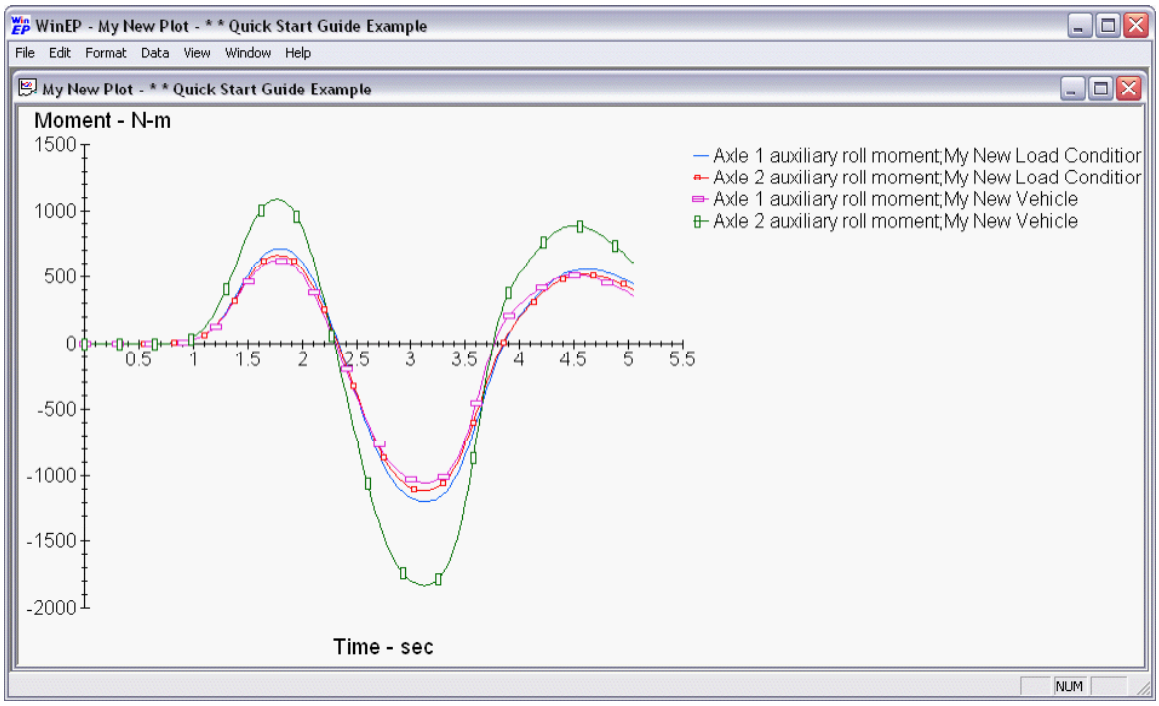


Figure 65. Newly defined plot for auxiliary roll moment.

Note The CarSim math models can produce hundreds or even thousands of output variables in each run. It is possible to make new runs with only subsets of the available variables, to save space in writing to file and to save time during post-processing. The checkbox on the **CarSim Run Control** screen (5) (Figure 63) to **Write all available outputs** is checked for the quick-start examples, to ensure that all variables are available for any new plots that might be defined as you explore the software.

7. Use the drop-down control (4) (Figure 63) for the second plot dataset and select the option to **Link to New Dataset**. Give it the name My New Cross-Plot. Click the blue button to go to the new dataset (Figure 66).

8. Use the drop-down control (3) (Figure 66) to select an existing simulation run, such as **Baseline**. The screen will refresh, and lists will be shown of available variable names for making plots using the Y axis (7) and X axis (12).

9. Choose the option **Select by Type** for both displays (Y (4) and X (8)). The screen will now show available types of variables in the two lists ((5) and (9)).

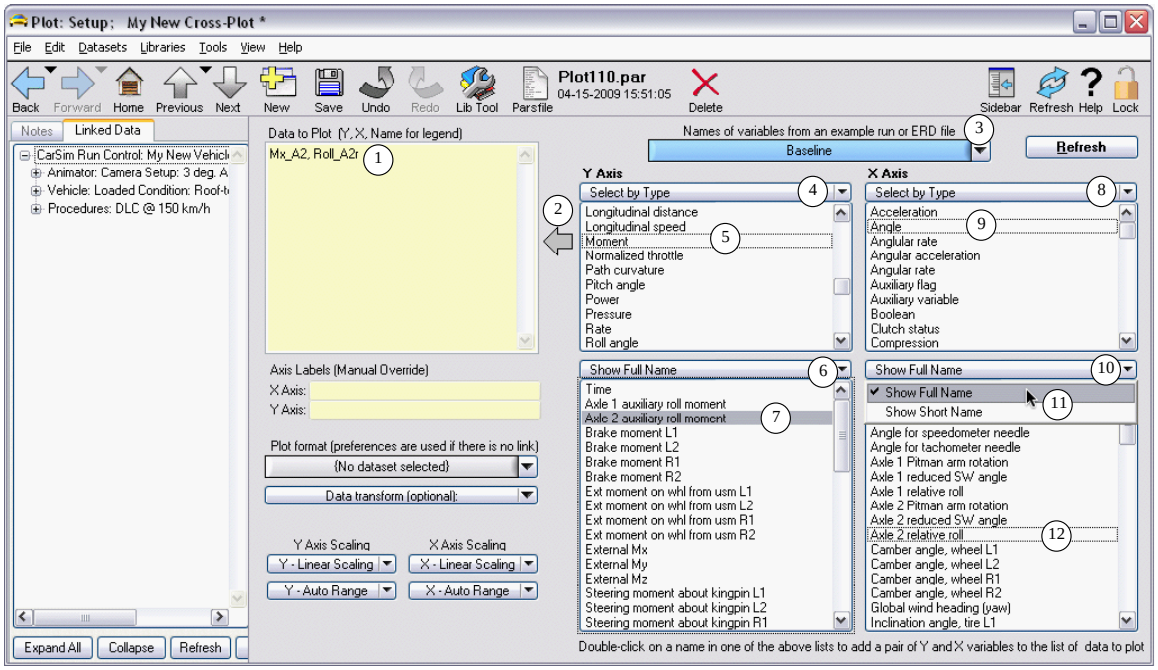


Figure 66. Using the interactive browser to select variables to plot.

10. Choose **Moment** for the Y-axis type (5) and choose **Angle** for the X-axis type (9). The screen will now show variables names of the selected types in the bottom lists (7) and (12). (The names shown at this time might be short, not matching the display seen in the figure.)

11. Choose the option **Show Full Name** (11) for the lists for both the Y axis (6) and the X axis (10). The screen will now show longer names, and should match the display in the figure. You can browse through these lists to choose variables to plot against each other.

a. Choose the variables **Axle 2 auxiliary roll moment** for the Y axis (7).

b. Choose the variables **Axle 2 relative roll** for the X axis (12).

c. Activate this combination of variables by double-clicking on either one (after both have been selected), or, by clicking the arrow button (2).

The screen should now match the appearance seen in Figure 66.

> **Note** The names that appear in the yellow field (1) are the short names of the variables. These are limited to eight characters in length. Although you can choose whether to display short or long names (see (11)), it is always the short names that are sent to the plotter to specify which variables are to be used from the output files generated by the CarSim math models.

12. Click the **Back** button or **Home** button to return to the **CarSim Run Control** screen**.**

13. Click the **Plot** button and view the two plots you have defined (Figure 67). Exit the plotter when you are through viewing the plots.

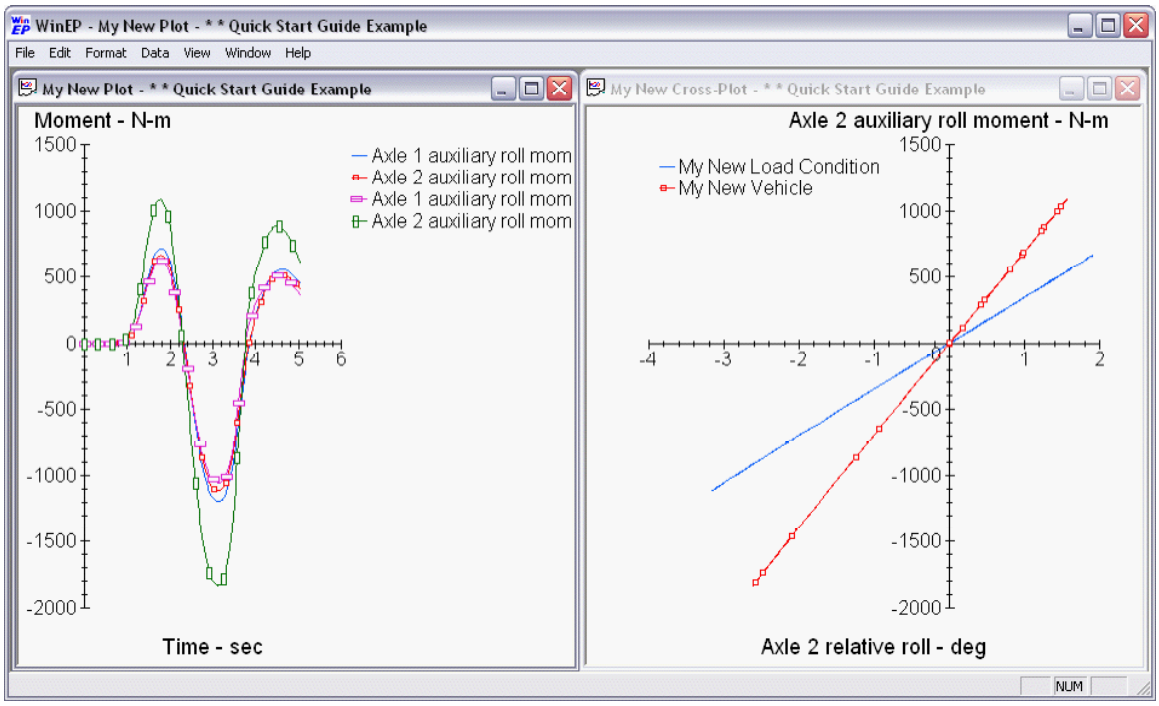


Figure 67. Two new plots generated to show auxiliary roll moment.

Review In the previous section, you looked through some of the on-line CarSim documentation and read reference material listing and defining hundreds of variables that are available for viewing with the plotter.

In this section, you have seen how the plots are defined in the CarSim database. The **Plot: Setup** screen has a yellow field that specifies variables to be plotted using short names. One way to define a new plot setup is to type the names of the variables to be plotted, in the main yellow field on the screen (1) (Figure 66). If you know the name, or can copy it from a text documentation file, this is a rapid way to create the dataset. The other way is to browse through the available variables and select the variables for plotting by clicking, as done in steps 8-11.

Although CarSim comes with a database that has hundreds of plot setups, you can create new ones to show the variables in which you are most interested.

Manage Multiple Databases

As you saw when going through Chapter 2, CarSim supports multiple databases on your computer. You can quickly move between databases and copy data between them as needed. Further, you can send and receive data to colleagues via email or other Internet transfer methods.

In this section, you will go back to the main database and transfer existing plot setup datasets into your quick-start database where they can be used immediately.

Continue with the **CarSim Run Control** screen that was used in the previous section.

1. Select the **Datasets** menu to see the datasets in the current library. The list should be short, including only the Baseline run and the new runs you made while following the tutorial in Chapter 2.

2. Select the **File** menu ① item **Recent Databases** ② to see a list of recently used databases (Figure 68). It should include the current one created for the quick-start tutorial in Chapter 2 (dimmed) and the database folder created when you originally installed CarSim ③. Choose the folder created when CarSim was installed. (In the figure, the original CarSim data folder is `C:\Documents and Settings\All Users\Documents\CarSim_Data`.)

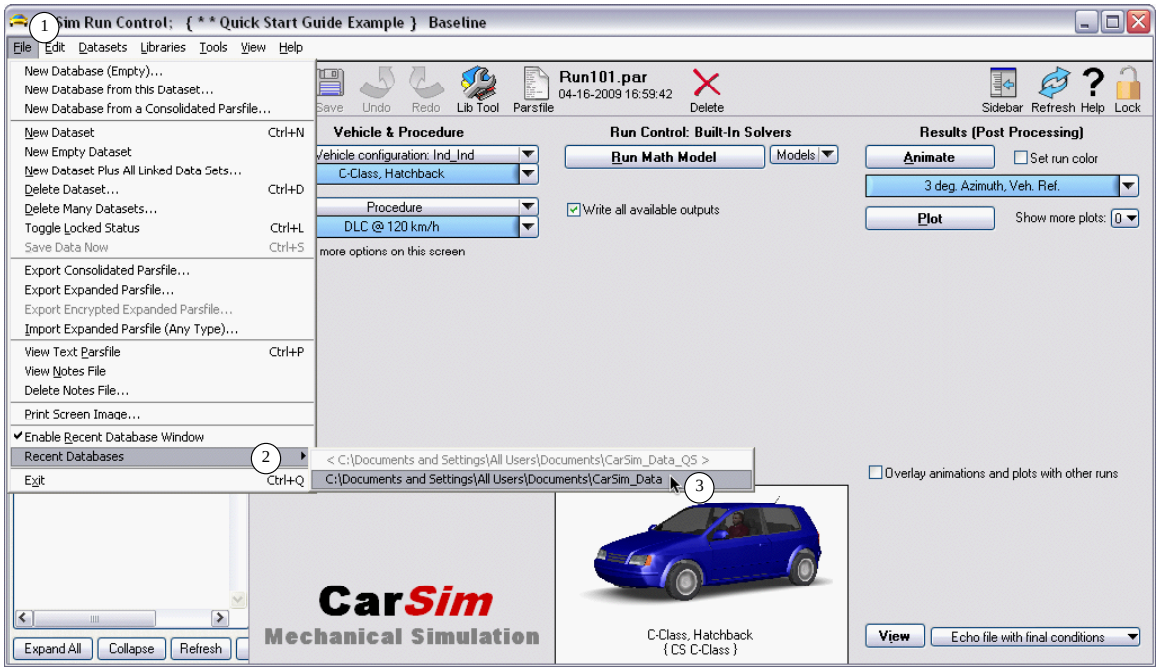


*Figure 68. Using the **File** menu to move between databases.*

CarSim will restart. In about 10 seconds or so, the **CarSim Run Control** screen will reappear. (If your installation is set to show license options, you will first view a window that shows these option. It has a box you can check to skip this display; do **not** check this if you are using a network license!)

3. Use the **Datasets** menu to see the datasets in the current library. The list should be much longer than when you viewed it in step 1, because this database includes many example runs that were included in the database originally installed with CarSim.

4. Select the **Help** menu item **About CarSim** to view the CarSim splash screen (Figure 69). This screen shows the current working directory ①, which is also the current CarSim

database. You can use this at any time to determine the current database location. Close the window.

*Figure 69. The **About CarSim** splash screen shows the current working directory (database).*

5. Select the **Libraries** menu (1) (Figure 70) to display all of the CarSim library screens. Go down to the submenu **Plot** (2) and choose the library **Plot: Setup** (3). This will take you to the **Plot: Setup** screen that you used in the previous section to define a new plot.

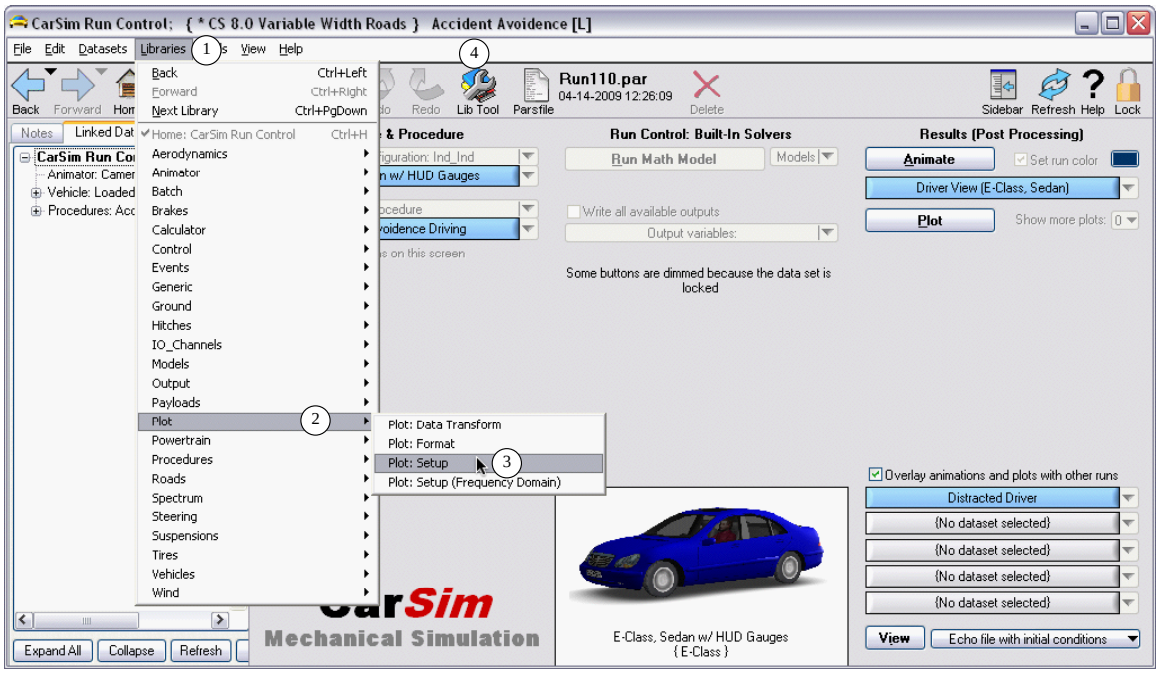


*Figure 70. Use the **Libraries** menu to navigate to a different library screen.*

Use the **Datasets** menu to see the datasets in the current library. The list shows that this database includes many example plot descriptions.

6. Click the **Lib Tool** button ④ (Figure 70) or select the **Tools** menu item **Library Tool**. Either action will bring up the **Library Tool** window (Figure 71).

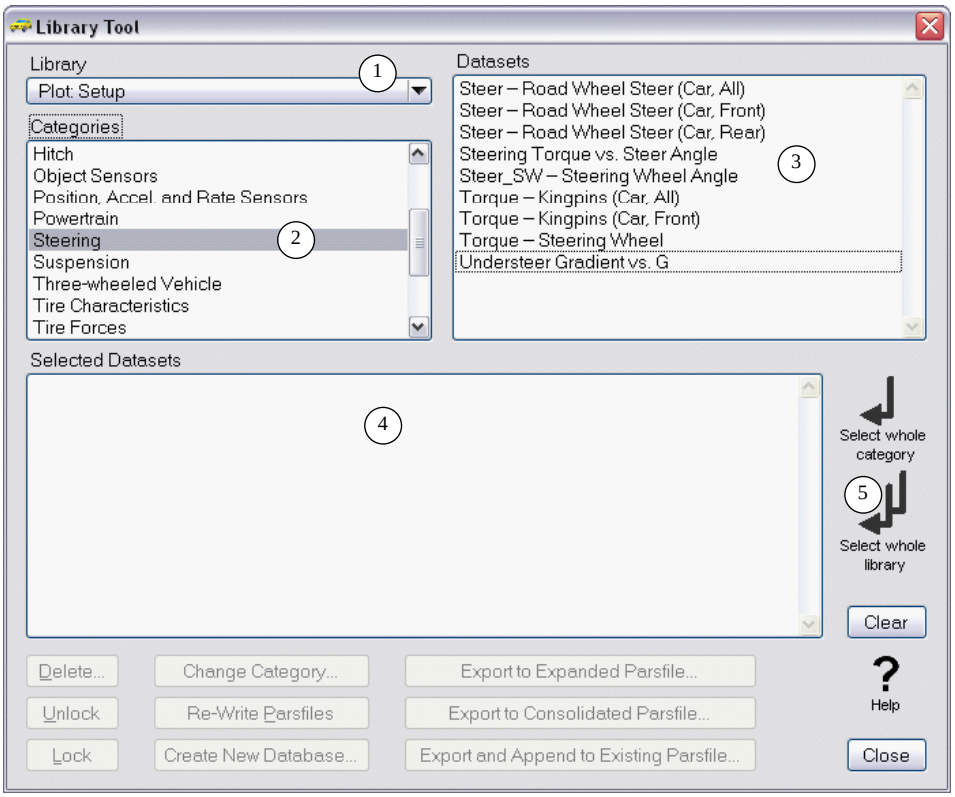


*Figure 71. The **Library Tool** window: before any datasets are selected.*

This dialog box has options to process a group of datasets whose names will be listed ④. It is automatically set to work with datasets in the library that was in use when the button or menu item was selected, but you can change to a different library using the drop-down control ①. The **Categories** list shows the categories of the datasets in the library ②, and the adjacent list shows the names of datasets in the currently selected category that are available for being selected ③.

7. Click the button **Select whole library** ⑤. This moves all datasets from all categories into the bottom list ④ (Figure 72). Once there are selected datasets, the buttons at the bottom of the window are active and you can export all plot setups for use in the other database.

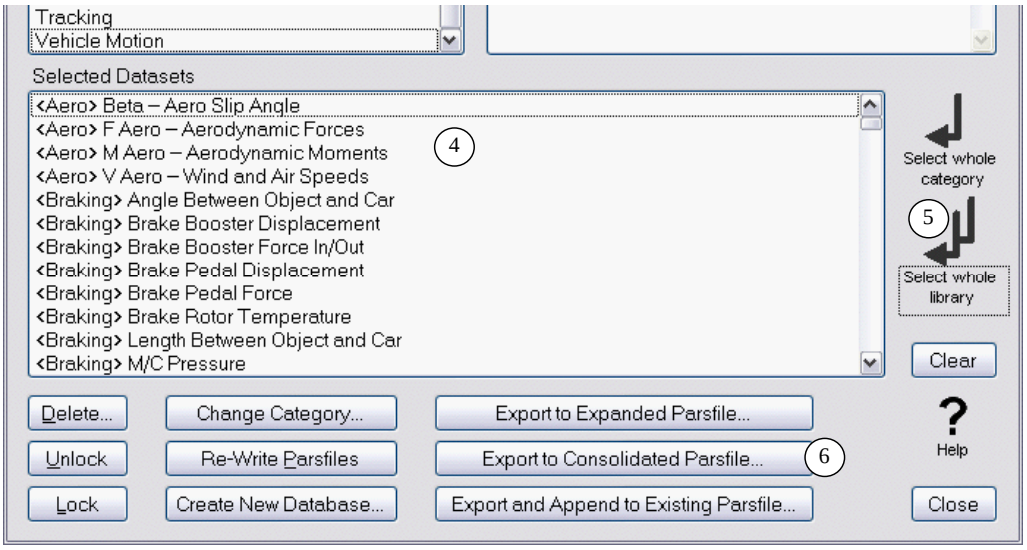


*Figure 72. The **Library Tool** window: after all datasets are selected.*

8. Click the button **Export to Consolidated Parsfile** (6). A dialog box appears for you to specify the name and location of the file that is about to be created (Figure 73). Choose a location that is convenient for you (1). (Remember where you create this file, because you will need to find a few steps later!) The default name is the name of the library (2); you can accept this or change it if you wish. Click the **Save** button (3) to complete this action.

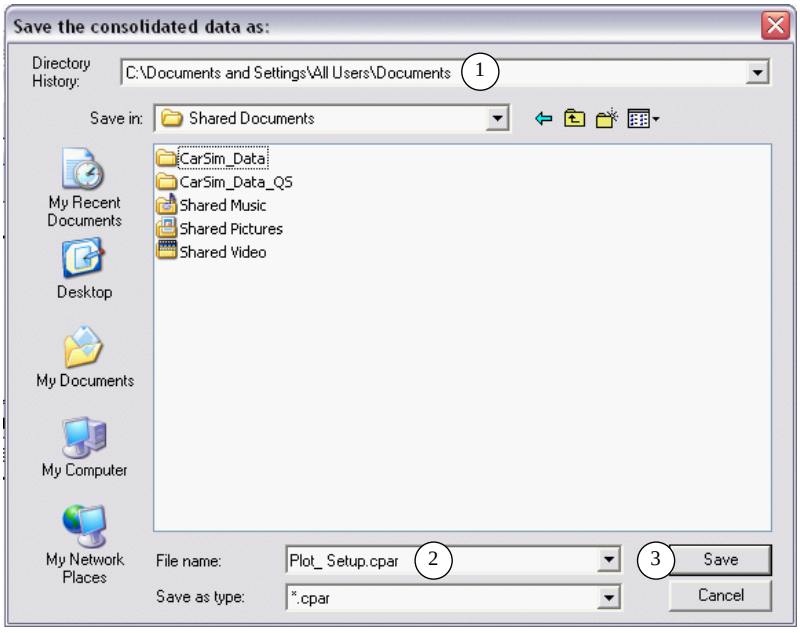


Figure 73. Specify name and location for consolidated parsfile.

This copies all selected datasets into a single archive file. The archive includes any files needed for the selected datasets to work. After CarSim finishes making the archive (10 seconds or so), close the **Library Tool**.

9. Select the **File** menu item **Recent Databases** and choose the one you created for the quick-start tutorial in Chapter 2. After CarSim restarts with the quick-start database, select the **Help** menu item **About CarSim** to confirm that you are once again in the small database you created earlier.

10. Select the **File** menu item **Import Expanded Parsfile (Any Type)** and select the file you created in step 9. You will be prompted about whether or not to overwrite existing support files (Figure 74); click the button **Do not overwrite** (1).

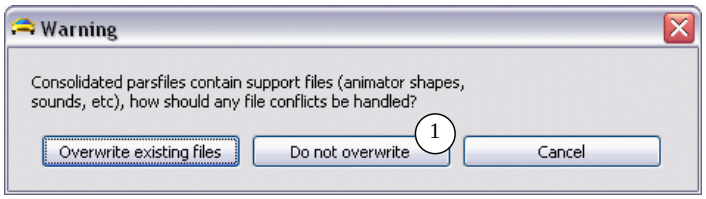


Figure 74. CarSim will ask how to handle conflicts with support files.

Next, you will be prompted to select an import option for possible dataset name conflicts (Figure 75); check that the option **Keep original names and do not import duplicate datasets** (1) is selected, and then click the **Import** button (2).

The import process can take a few minutes.

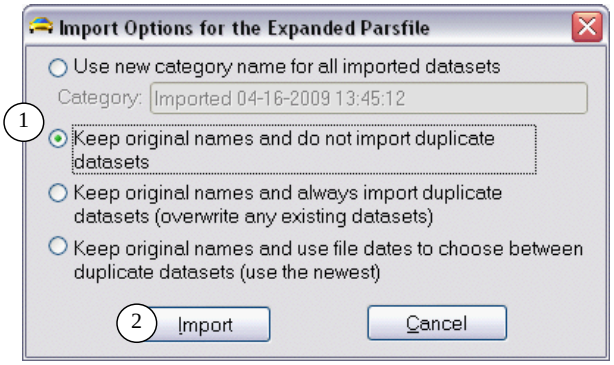


Figure 75. Import options for an expanded parsfile.

11. Go to the dataset that has your new plots from the previous section (**My New Vehicle**, Figure 76). Use the drop-down control next to one of the plot link buttons (2) to see the menu of available plots. Notice that one of the plots is **Aux. Roll Moment** (3) in the category **Suspension** (4). Select it and click the **Plot** button (1).

The plot selected, which you just imported from the other CarSim database, is identical to the one created in the previous section.

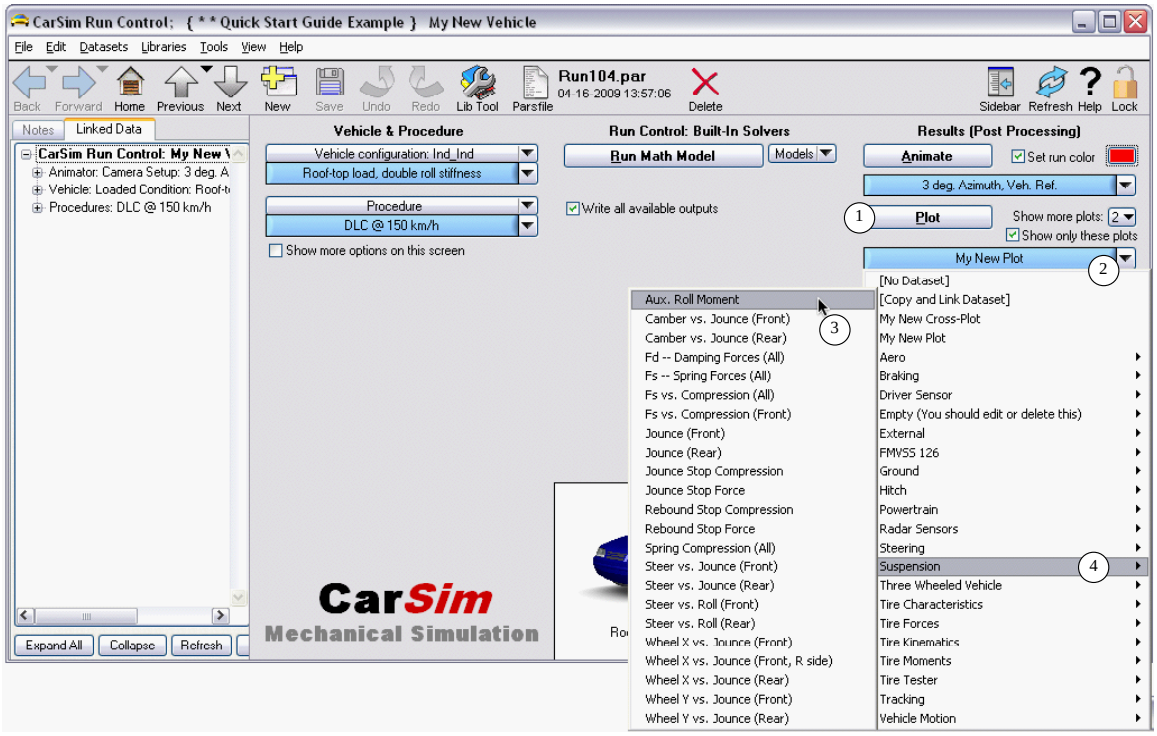


Figure 76. There are now many plots available in the quick-start database.

Review You have now performed the two basic parts of moving data: exporting a group of datasets from one CarSim database, and then importing those datasets into another database.

The CarSim database that is initially installed contains many example vehicles, procedures, animation shapes, plot settings, model extensions, and other datasets that help get started using the full range of CarSim features. Although having many examples can be convenient when looking for an example to start from, it can slow you down because there are so many data sets to choose from.

You have now seen that it is easy to go back to the original installation database, grab datasets of interest, and bring them to the database in which you are working.

Browse the Database

Continue the CarSim session from the previous section. You should currently be in the small database made for the quick-start tutorial.

1. Select the **File** menu item **Recent Databases** switch to the full CarSim database created during installation (e.g., `C:\Documents and Settings\All Users\Documents\CarSim_Data`.)

2. If the sidebar does not show notes, then click the **Notes** tab.

> **Notes** The example runs that come installed with CarSim are intended to show different features of the software. Most of the example runs and vehicles have notes.

3. Select the **Datasets** menu to view the list of existing run categories (Figure 77). Those that show features added in the current release have names that begin with '*' so they appear at the top (the categories are sorted alphabetically). You can use this menu to jump to any dataset in the library.

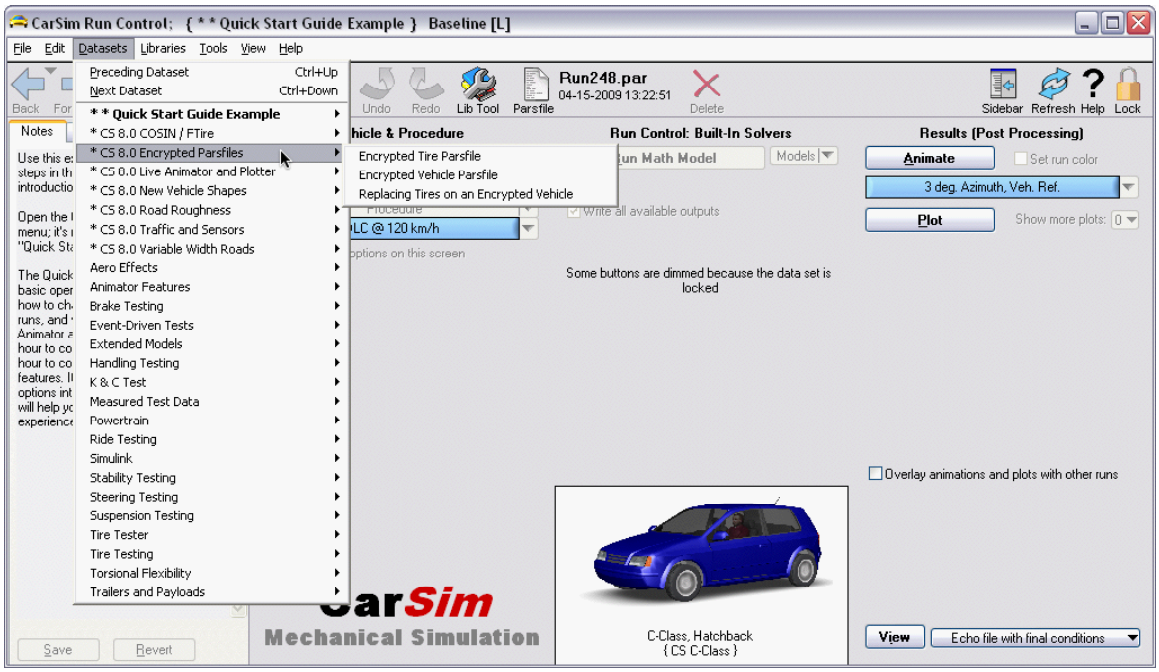


*Figure 77. View all of the datasets in a library using the **Datasets** menu.*

4. Alternatively, the **Previous** and **Next** buttons can be used to go through the datasets in sequence. 

5. Initially, all datasets are locked. However, all simulation runs have already been made, which allows you to view results using the animator and plotter. You can browse through the runs in the **CarSim Run Control** library and view any of the run conditions using the **Animate** and **Plot** buttons. See the **Notes** in the sidebar for information about the run you are viewing.

6. In general, if the data screen you are viewing has blue button links, you can click on any of them to view the linked data.

7. As with a web browser, you can trace your steps back using a **Back** button (1) (Figure 78). Click on the **Back** button to go back one level (or type Ctrl+←). Click and hold the small triangle (2) next to the **Back** button to pull down a menu (3) of all of the screens that can be reached by repeatedly clicking the **Back** button; you can use this menu to jump to any of these screens.

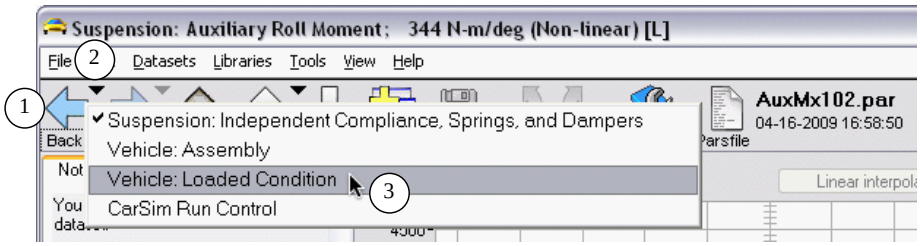


*Figure 78. A menu of previously visited screens with the extended **Back** control.*

8. As with a web browser, you can also repeat your links forward using the **Forward** button (or type Ctrl+→). Click on the **Forward** button to go forward one level. Click and hold the small triangle next to the **Forward** button to pull down a menu of all of the screens that can be reached by repeatedly clicking the **Forward** button.

Review A CarSim database contains much information, organized into many libraries. CarSim supports several methods for navigating through this data:

1. Use the **Library** menu to jump to any library. Within a library, use the **Dataset** menu to jump to any dataset.
2. Click on blue links the same way you click on a web link in a web browser; the result is that you view the dataset in its own screen.
3. Return to the previously viewed screen using the **Back** button (or type Ctrl+←).
4. Go forward, as with a web browser, using the **Forward** button (or type Ctrl+→).
5. View the **Linked Data** tree in the sidebar to see all of the currently linked datasets, and jump to any dataset by double-clicking on it.

About Procedures

In this section, you will get some more datasets from the full CarSim database and import them into the quick-start database. You will use the same basic method that was described earlier in this chapter for transferring plot settings.

Continue the CarSim session from the previous section. You should currently be in the full database from the original installation. (If you are not in the full database, use the **File** menu item **Recent Databases** to move there.)

1. Click the **Lib Tool** button or select the **Tools** menu item **Library Tool**. Either action will bring up the **Library Tool** window.
2. Press the **Library** drop-down control (1) (Figure 79). A scrollable list immediately appears; choose the library **Procedures** (2) and click the **OK** button (3). The **Library** control should now display the name **Procedures** (1) **(**Figure 80**).**

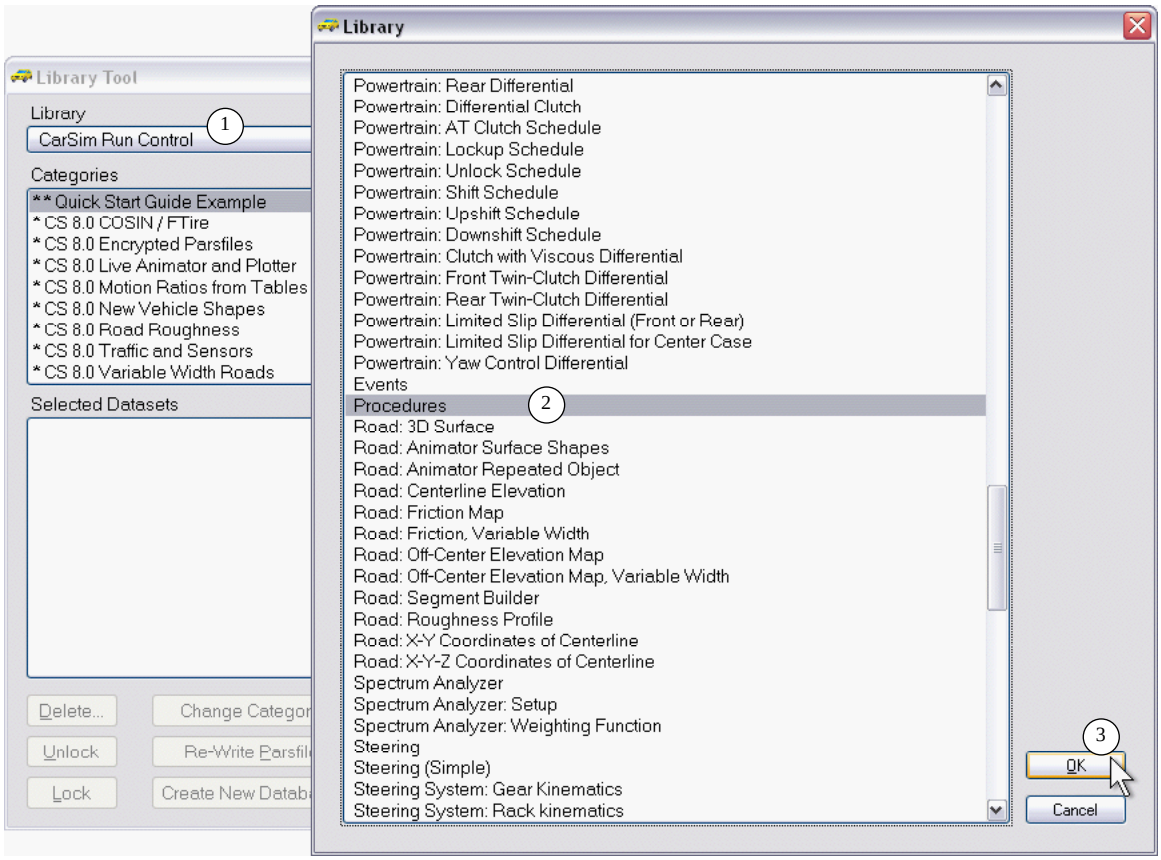


*Figure 79. Choose a library for use in the in **Library Tool**.*

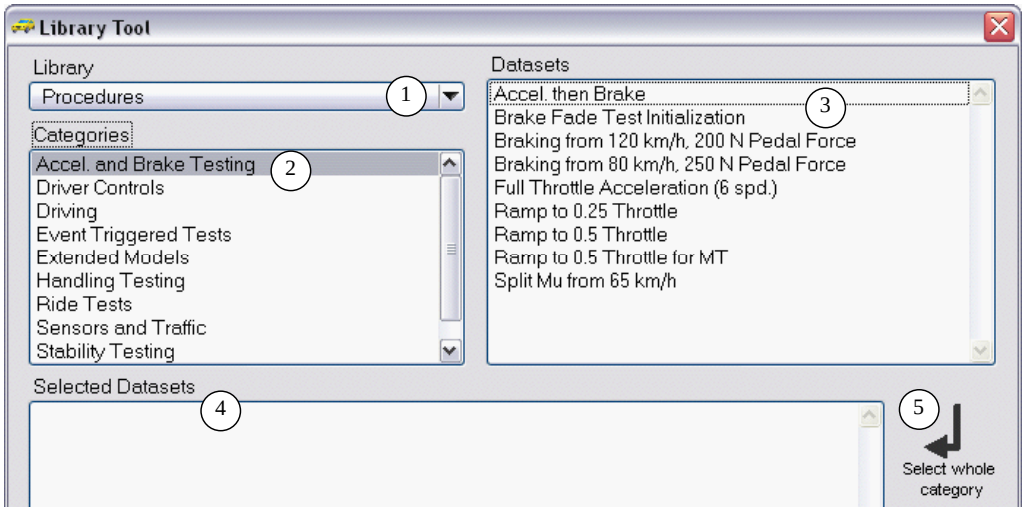


*Figure 80. Datasets in the category **Accel. and Brake Testing**.*

3. Move all of the datasets in the category **Accel. and Brake Testing** (2) to the bottom list **Selected Datasets** (4). There are two quick ways to do this:

a. Double-click on the category name (2).

b. Or, click on the button **Select whole category** (5).

Either way, all of the datasets will be moved to the **Selected Datasets** list (4) (Figure 81).

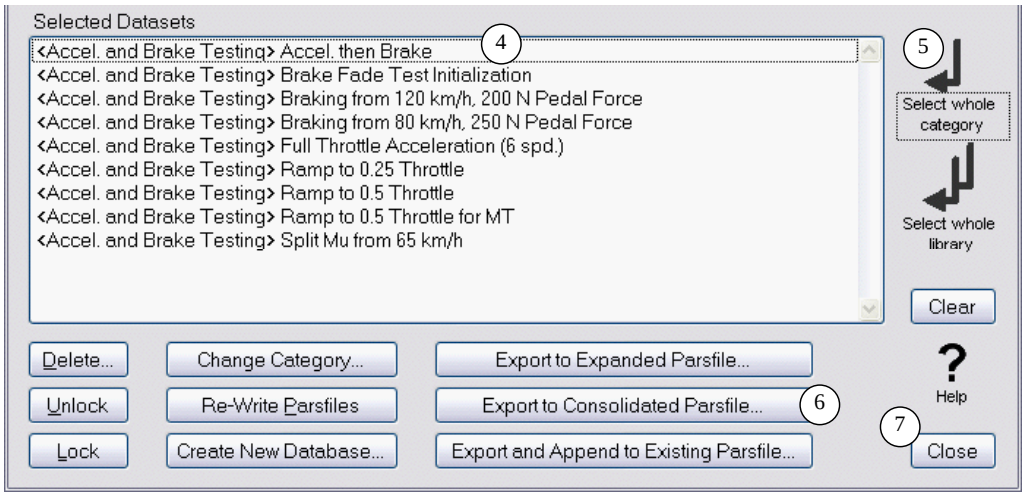


*Figure 81. Datasets from **Accel. and Brake Testing** moved to **Selected Datasets**.*

4. Click the button **Export to Consolidated Parsfile** (6). As before (in the section **Manage Multiple Databases**), you are prompted to specify a name and location for the file. Save this consolidated parsfile in a convenient location.

Close the **Library Tool** window (7).

5. Select the **File** menu item **Recent Databases** and choose the database you created for the quick-start tutorial. After CarSim restarts with the quick-start database, select the **Help** menu item **About CarSim** to confirm that you are in the intended database.

6. Select the **File** menu item **Import Expanded Parsfile (Any Type)** and select the file you created in step 4. As before, you will be prompted about how to handle support files to overwrite existing copies; as before, click the button **Do not overwrite**. You will also be prompted to select an import option for possible dataset name conflicts; as before check that the option **Keep original names and do not import duplicate datasets** is selected, and the continue with the import.

7. Go to the baseline run with which you started in Chapter 2: {*** * Quick Start Guide Example } Baseline**. If the dataset is not in view, use the **Next** button to browse, or the **Datasets** menu to go directly to the dataset.

8. Click the **New** button to create another new dataset, and give it the name Temp (Figure 82).

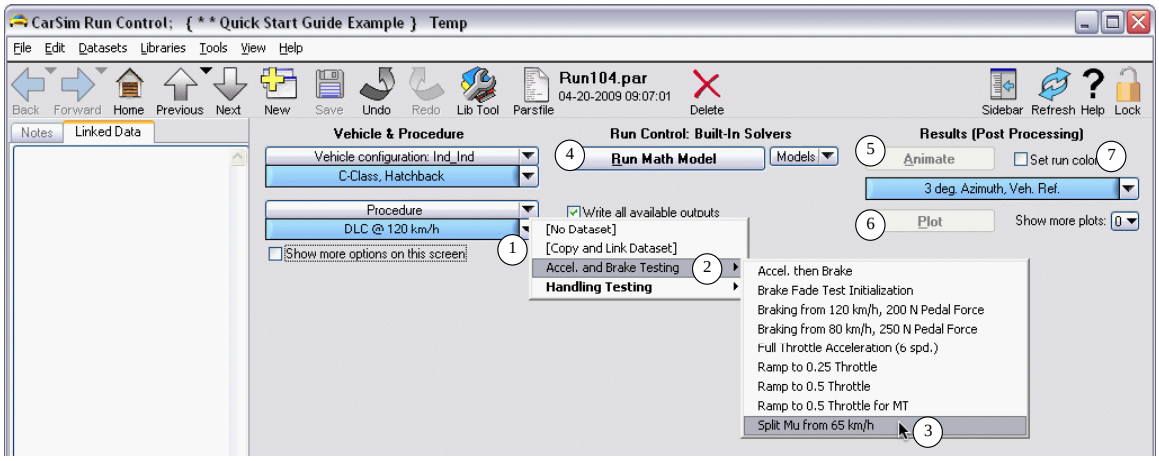


Figure 82. Choose a procedure for braking on a splu-mu surface.

9. Press the drop-down control next to the **Procedure** blue link (1). Notice that new datasets are available that were imported in step 6 above. In the category **Accel. and Brake Testing** (2), select the dataset **Split Mu from 65 km/h** (3).

10. Click the **Run Math Model** button (4).

11. Check the **Set run color** button (7) and change the run color to yellow (it will show better contrast in the animation).

12. Click the **Animate** button (5) to see results similar to those shown in Figure 83. You will probably want to zoom out—the camera position for the double lane change is a little close for this test.

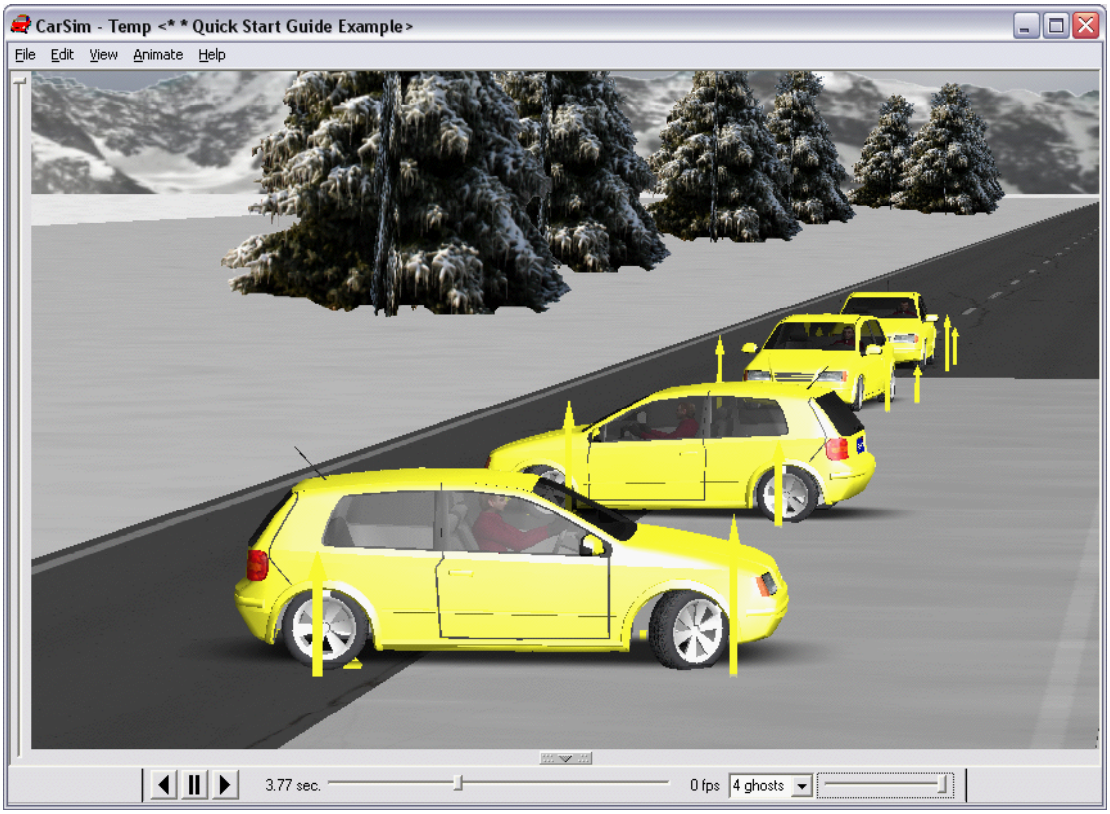


Figure 83. Baseline vehicle running a brake test on split-mu surface.

Notice that the road appearance is completely different than in past examples with double lane changes. There are trees with snow, mountains in the background, and the road has one side lightly colored similar to ice.

After viewing, exit the animator.

13. Click the **Plot** button. The plotter will appear with many plots, related to braking. There are plots of vehicle motion (acceleration, pitch, yaw), wheel speed, suspension deflection, tire forces and longitudinal slip, etc.

After browsing the plots, exit the plotter.

14. Click the blue link button (1) (Figure 82) to view the **Procedure** dataset **(**Figure 84**)**. In this figure, three regions of the screen have been marked with black rectangles ((1), (2), (3)).

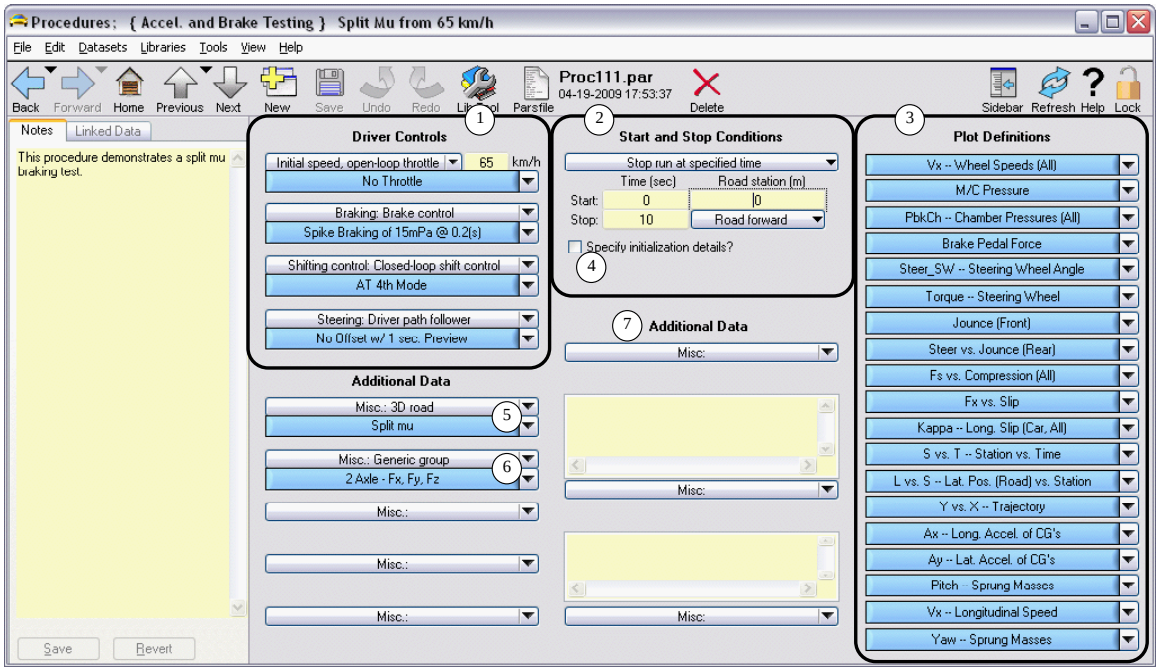


Figure 84. The dataset for the split-mu braking procedure.

a. The settings in the upper-left region of the screen (1) define driver controls for the procedure. These include the speed control, braking, gear shifting, and steering.

b. The settings in the upper-middle region define conditions for starting and stopping the run. In the double-lane change example, the run was stopped when the vehicle reached a specified position (road station). In this braking example, the run will stop at 10 seconds.

   It is also possible to specify details about how the vehicle is initialized at the start of the run. The checkbox (4) can be checked to reveal more settings that control the position of the vehicle, matching wheel speed to forward speed, setting approximate equilibrium suspension deflections, etc. If not checked, default initializations are used.

c. The links in the upper-right region of the screen (3) establish plots that will be generated for this procedure when the **Plot** button is clicked on the **Run Control** screen.

In addition to the three regions shown in the figure, there are links and yellow fields for additional data. In this example, one of the links (5) includes a road dataset that has physical properties (geometry and friction) and animation specifications. Another link (6) includes specifications for showing the arrows proportional to tire forces in the animations.

Review You have now made a new run with a completely different type of procedure, going from a transient handling maneuver to a braking test on a split-mu surface. In doing so, you again moved data from one CarSim database to another.

With just one change in the run definition (changing the procedure), CarSim used a different road, with different animation appearance; different controls were applied; different stopping conditions were used to end the run (time instead of distance); different plots were generated for viewing results.

4. What's Next

You have now completed the hands-on introduction to CarSim.

In Chapter 2, you made a clean new database, made a run, and then used the Animator and plotter to view simulation results. You made some new datasets and runs involving a new procedure, a new loading condition, and a new vehicle with a modified suspension.

In Chapter 3, you defined new plots, and transferred information from one CarSim database to another. You changed from a handling double-lane change test to a split-mu braking test by changing just one setting on the **Run Control** screen.

You have also seen how to access the extensive on-line help in CarSim, from the **Help** menu and from the users section of the web site: www.carsim.com/users. Most of these documents can be used when needed. For example, when you are looking at a road dataset, type F1 or click the **Help** button for details on how to define roads in CarSim. If this is not enough, then use the **Search Help** feature to search the entire CarSim documentation using words and phrases.

Now that you have learned the basics for using CarSim, there are a few more documents that we recommend reading as soon as you have time:

1. The **GUI and Database (VS Browser)** manual (near the top of the **Help** menu) gives reference information for the CarSim menu, GUI controls, and the database.

> **Note** The VehicleSim simulation architecture is used in the products BikeSim, CarSim, and TruckSim. The products share some of the documentation, and in these cases, the documents refer to programs and designs using the more generic name VehicleSim (VS).

2. If you will be working with Simulink, you should read the tech memo **Example: Running with Simulink**. This continues with the braking example that was used at the conclusion of Chapter 3, and shows how you connect a CarSim vehicle math model with a controller defined in Simulink.
3. The **VS Solver Programs** manual (in the **Reference Manuals** submenu of the **Help** menu) gives reference information about the solver programs, such as input files, output files, and basic format rules.
4. The **VS** Commands manual (also in the **Reference Manuals** submenu) describes the rules for symbolic equations and model extensions that can be made with VS commands.

Another option for quickly learning about CarSim and its more advanced features is to take a one-day training course from Mechanical Simulation. Please see `www.carsim.com` for details.

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