Appendix 6 New Features in v2.0

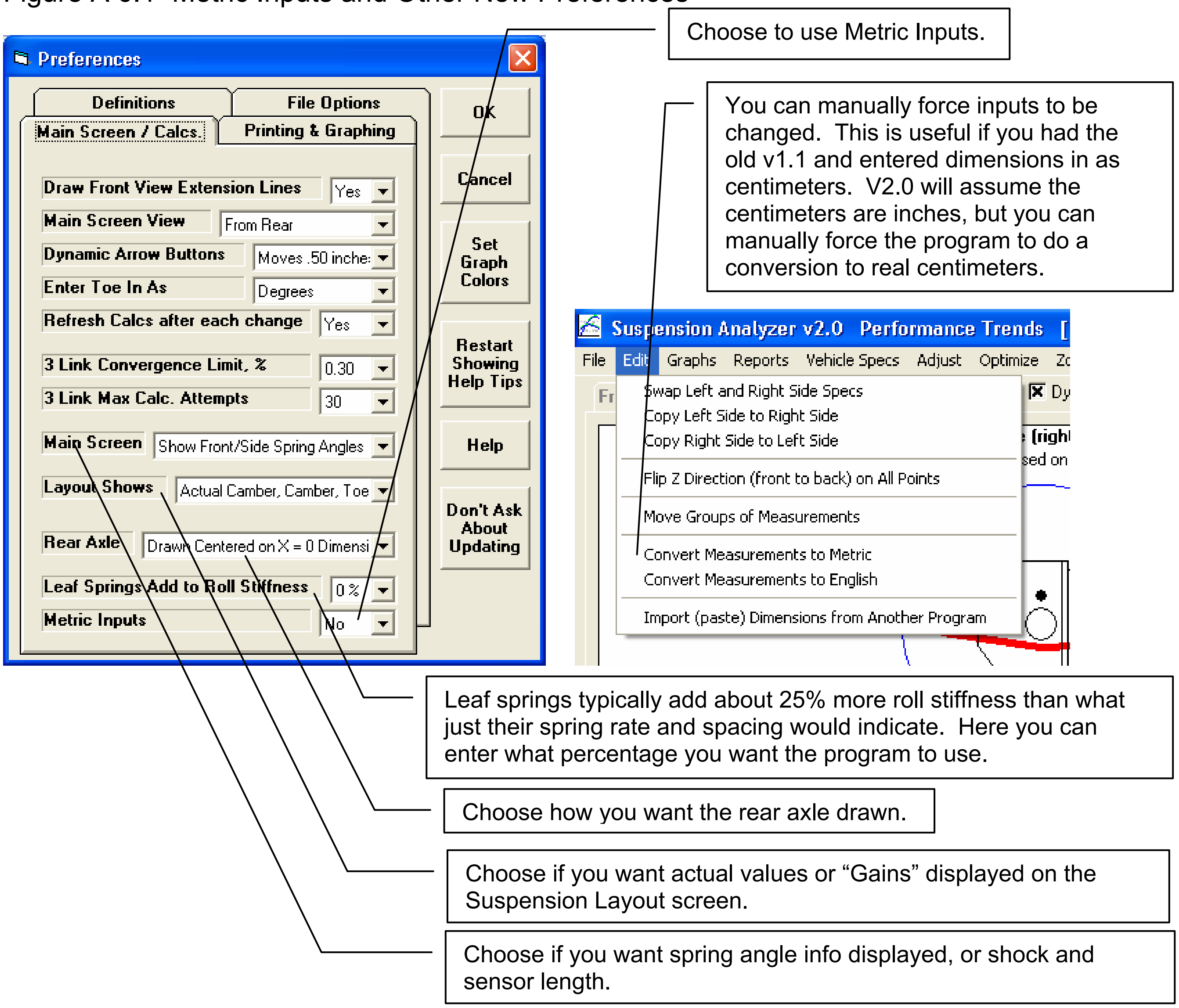
Version 2.0 was released in 2006 and added the following major features:

- A new Preference of Metric inputs was added. Inputs are entered in Centimeters, KG for weight, and Kg/Cm for spring rate. The program keeps track of what units are used for each suspension file. If you are in, say, Metric mode and open a file saved with English units, the units will be converted to metric once it is opened. You can also manually force a file to be converted by clicking on Edit (top of main screen) then selecting either Convert Measurements to Metric or Convert Measurements to English. See Fig A 6.1.
- Added a new calculation called Front Lateral Load Distribution, or FLLD% and Rear Lateral Load Distribution, or RLLD%. These calculations are similar to "roll couple" and can be used to find a "balanced" setup by adjusting spring and roll bar rates, and roll center heights. This feature is only in the Full Vehicle version and is discussed in detail below. See Fig A 6.2 and A 6.3.
- Several new "Optimize" features and options have been added, including one to find your desired FLLD% automatically. This is discussed in detail below. See Fig A 6.3 and A 6.4.
- A Watts Linkage has been added to the possible "Lateral Locator" devices, in addition to the Panhard bar. This feature is only in the Full Vehicle version and is discussed in detail below. See Fig A 6.5.
- A solid axle with leaf springs is now a possible Rear Suspension type. This feature is only in the Full Vehicle version and is discussed in detail below. See Fig A 6.6 and Fig A 6.9.
- A coil over spring can now be mounted on the upper A arm, similar to that used in the early Ford Mustangs. This feature is only in the Full Vehicle version. See Fig A 6.9.
- A coil over spring can now be mounted inboard of the frame attachment point on the upper A arm. This is sometimes called a "rocker arm" spring and is common on Formula cars with independent rear suspensions. This feature is only in the Full Vehicle version. See Fig A 6.9.
- A Torsion Bar spring can be used with either a Double A Arm or McPherson Strut suspension. This feature is only in the Full Vehicle version. See Fig A 6.9.
- The program now has Backup/Restore commands. Click on File at top of main screen and select either Backup or Restore. The Restore command has 2 options, either restore all files from a previous backup or just 1 file at a time. See Fig A 6.7.
- When Opening a file, a "Find" button has been added, letting you enter some phrase or sequence of characters to look for in a particular files name. This helps you locate files faster.
- You can now import dimensions directly to the program from either a file or by pasting them after copying them from another program, like Microsoft Excel. This feature is only in the Full Vehicle w Data Logger Option version and is discussed below. See Fig A 6.13.
- The program can now read "freeform" ASCII files of data logger data. We've tried to make the Suspension Analyzer "smart" enough to be able to recognize data from various data loggers, like Motec, Pi and AIM. In addition, you no longer have to provide track map data, as the Suspension Analyzer can generate this info itself from distance, velocity and lateral Gs data. This feature is only in the Full Vehicle w Data Logger Option version and is discussed below. See Fig A 6.12.
- A new Preference lets you select to either have Toe Gain, Caster Gain and Camber Gain be displayed in the suspension layout drawing, or more simply Toe, Caster and Camber. The "Gains" are the amount of change in these parameters for a given amount of suspension movement. See Fig A 6.1 and A 6.8.
- New Preference for choosing to have the Rear Suspension either to be "Draw Centered Between Tires" or "Centered on x = 0 Dimension". See Fig A 6.1.
- Program now remembers the printer orientation (portrait/landscape) you're using and restores it when you restart.
- The program now draws the transmission angle (in front of the driveshaft). You may not see this unless you use the Zoom options to slide the side of the rear suspension to one side. See Fig A 6.6.
- The locking algorithm now uses a computer hardware number which is more stable. This means that you will be less likely to get a new unlocking code when you make changes to your computer.
- Version 2.0 will look for and allow automatic or manual importing of all your v1.1 files. See Fig A 6.7.
- A new Preference was added to let you choose to display the Spring Angle (front and side view) or shock and sensor length. See Fig A 6.1.
- Several new example Suspension Files have been added.

Also, click on Help, then Display Readem.doc file to display a more detailed list of each item which has been change or added, and any "bug" fixes.

Metric

Figure A 6.1 Metric Inputs and Other New Preferences



FLLD (Front Lateral Load Distribution)

When a car makes a turn, weight is transferred from the inside tires to the outside tires. However, how this weight transfer is split between the front and rear has a huge impact on the feel and handling of the car. If more weight transfer occurs on the front of the car, the outside front tire is being "overworked" more than the rear outside tire, causing less cornering traction at the front. This is more likely to produce understeer or a push. Very simplistically, if the Front Lateral Load Distribution is 50%, that means the weight transfer split between front and rear is the same, and that should produce neutral handling. The book "Race Car Vehicle Dynamics" by Milliken and Milliken (with assistance by Terry Satchell) discusses this concept in detail. This concept is similar to the idea of balancing the front and rear roll angles presented in recent magazine articles.

Figure A 6.2 shows the program displaying the FLLD for the current vehicle (currently 44%, which would tend to have Moderate Oversteer) during the transition between releasing the brakes and going to the throttle, at the apex of the turn (transistion between braking and power). During braking and under acceleration, the weight transfer is much more complicated, and the FLLD concept can not be as easily applied.

Figure A 6.2 FLLD and RLLD Displayed in Results with Roll Couple

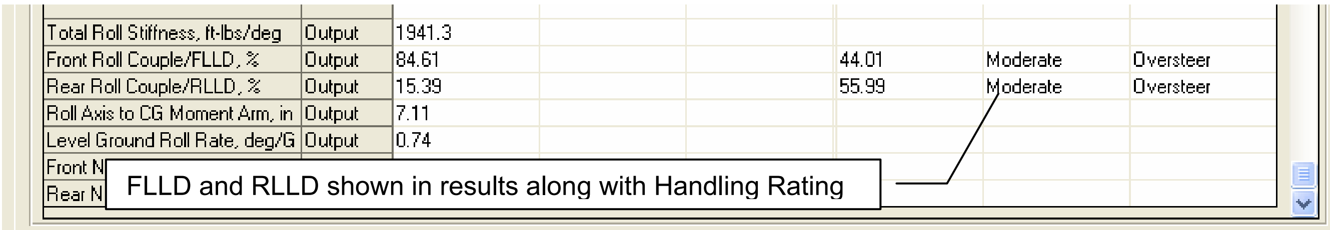
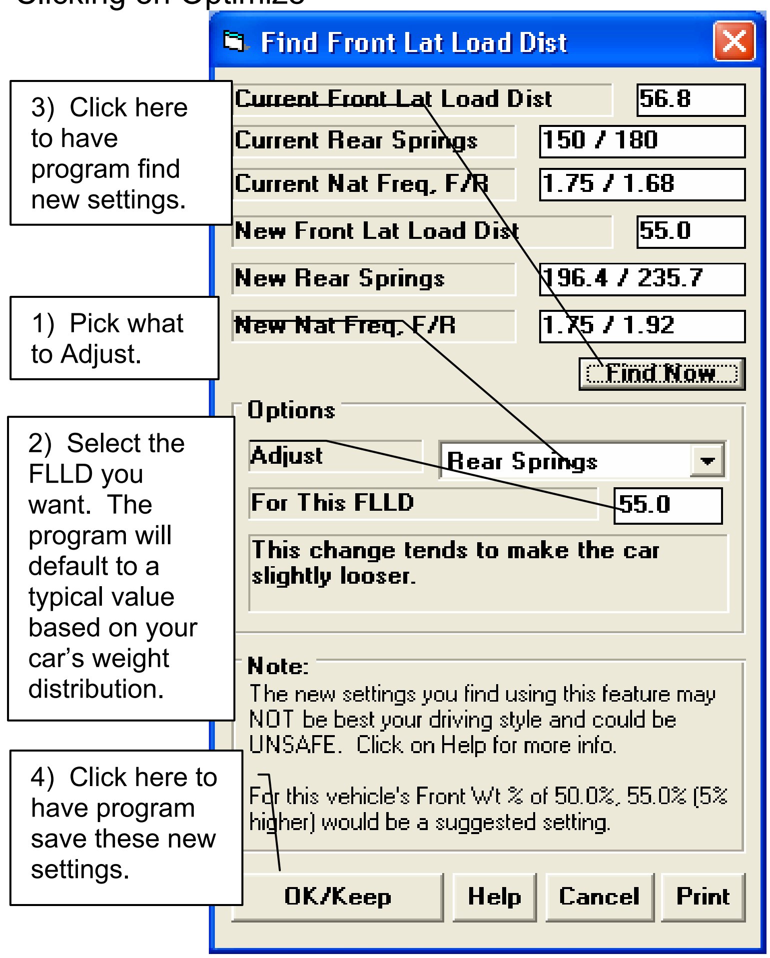


Figure A6.3 is displayed if you click on the "Find" button shown in Figure A6.2. This "Find FLLD" screen lets you find a certain Front Lateral Load Distribution (FLLD), which can be a good indication of how the car will handle at the apex or transition of the turn (no power, no braking).

Figure A 6.3 Find Front Lateral Load Distribution by Clicking on Optimize



Pick the 'Adjust' factor to tell the program what vehicle component(s) you want to adjust. Enter your desired 'For This FLLD', then click on the 'Find Now' button. For perfect theoretical 'Balance', the FLLD should be 50%. However, from experience, Milliken suggests a target 'starting point' FLLD value of 5 percentage points higher than the percent weight on the front tires (100% - Rear Wt % = Front Wt %). By default, the program will load in this value, but you can change it to anything else you want. Higher FLLDs tend to make the car tighter, with more understeer. Lower FLLDs tend to make the car looser, with more oversteer.

There are several ways to obtain a certain Front Lateral Load Distrbution percentage. To reduce the possibility of using very strange settings, the program will calculate the average front and rear natural frequencies for the springs. If these frequencies are significantly different than those typically used, the program will warn you. Typically, the front natural frequency will be in the range of 1.4 to 2.0 and the rear will be .1 to .5 points lower than the front.

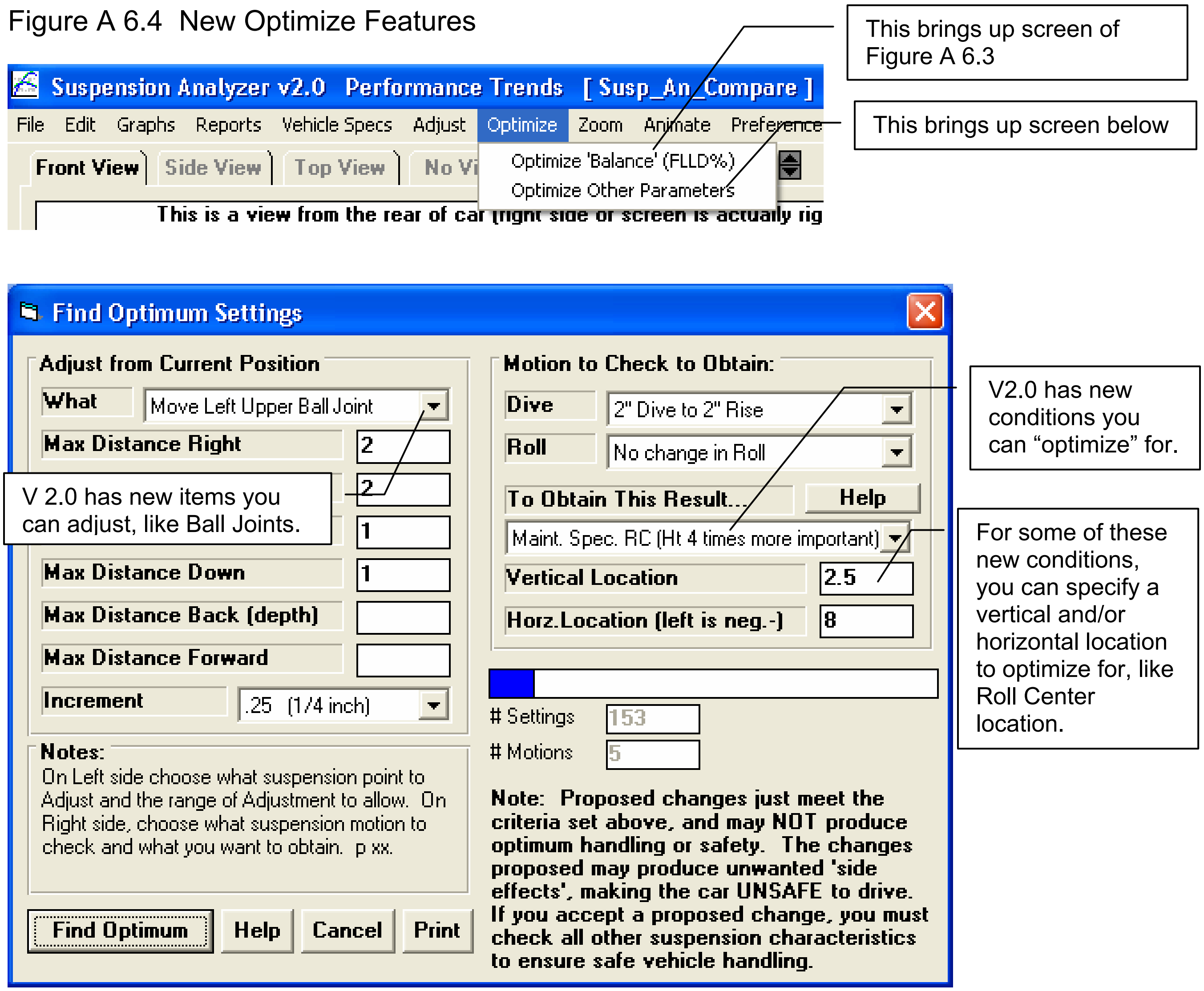
For many vehicle combinations, the program can not find settings to match your requirements. Many times this is due to the Front or especially the Rear roll centers being too high. High roll centers transfer more weight laterally through the suspension linkages and less through the springs, making the springs and roll bar have less effect on this tuning factor. You may then want to have the program adjust the Rear Roll Center to find the FLLD you desire. After you adjust the Rear Roll Center and keep this change (click on OK/Keep), then you can go back into this screen and try adjusting springs and/or roll bar and they are likely to have more affect.

The new settings you find using this feature MAY NOT BE THE BEST AND COULD BE UNSAFE. USE YOUR JUDGEMENT when making adjustments based on this concept.

New Optimize Features

Figure A 6.4 shows some of the new features in the Optimize screen.

Figure A 6.4 New Optimize Features



To Obtain This Result…

Choose what result you want to obtain, like to maintain a certain Roll Center Location (Left or Right) or Roll Center Height, Bump Steer (which is Toe In/Out), or Camber. If Roll Center Height or L/R are not mentioned, then you are asking both to be kept stable (maintained).

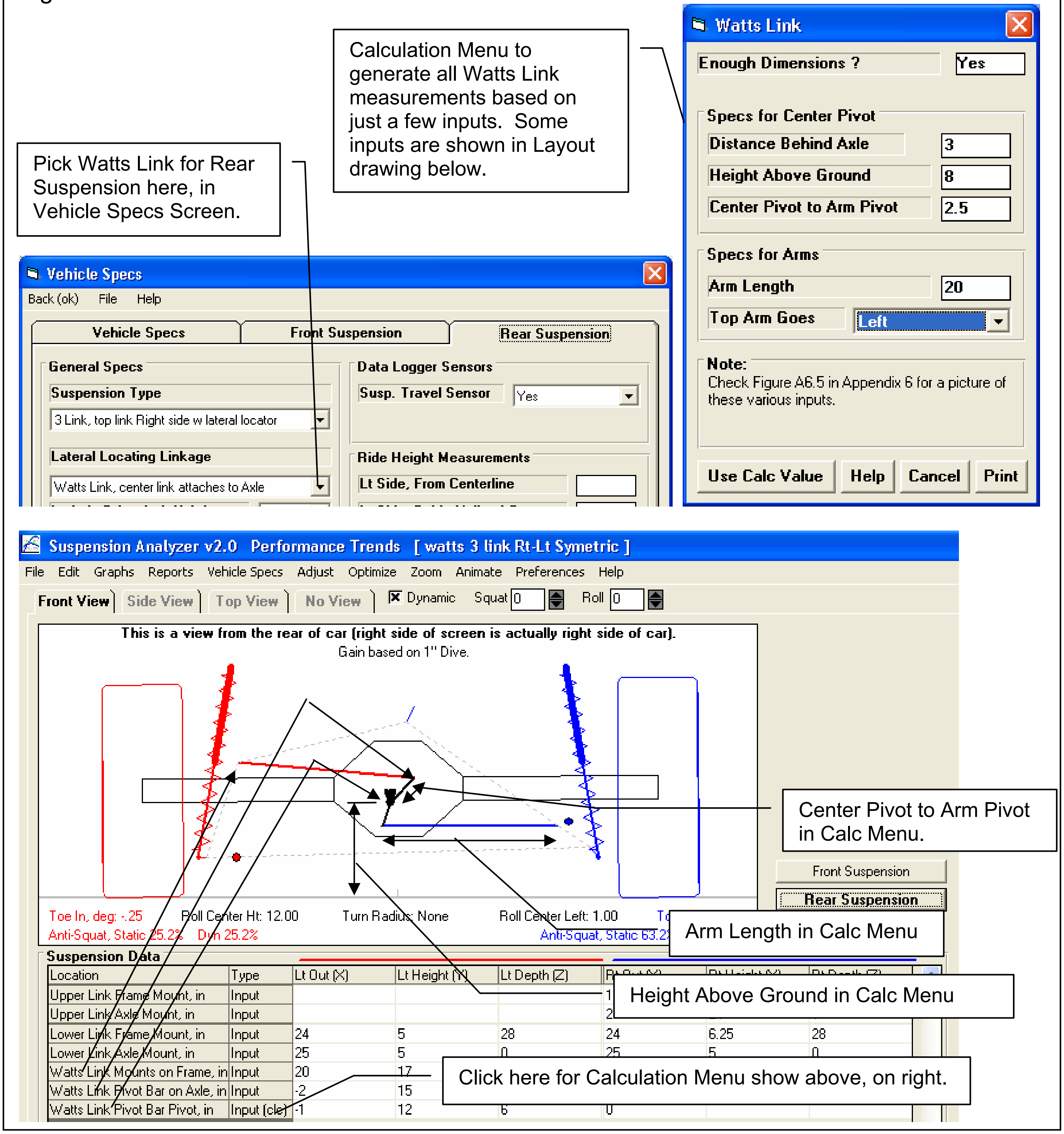
Some options let you try to match a 'Specified' Roll Center Vertical or Horizontal location. If you select this option, then the Vertical and Horizontal data entry boxes become enabled for you to enter values. Note: To specify a Horizontal Location LEFT of center, enter a negative (-) number. Roll Center Height typically has a larger impact on handling than location Left or Right, so some of these options let you concentrate, say, 4 times more on maintaining height constant than horizontal motion. This means that a 1 inch change in height will be considered as important as a 4 inch horizontal change.

See Section 2.6, page 47 in this manual for more explanation of this Optimize Screen.

Watts Link Lateral Locator

V2.0 lets you select a Watts Link (with the center pivot mounted to the axle) or a Panhard Bar as the lateral locating device for solid axle suspensions. Figure A 6.5 shows some major options with this feature.

Figure A 6.5 Watts Link Features

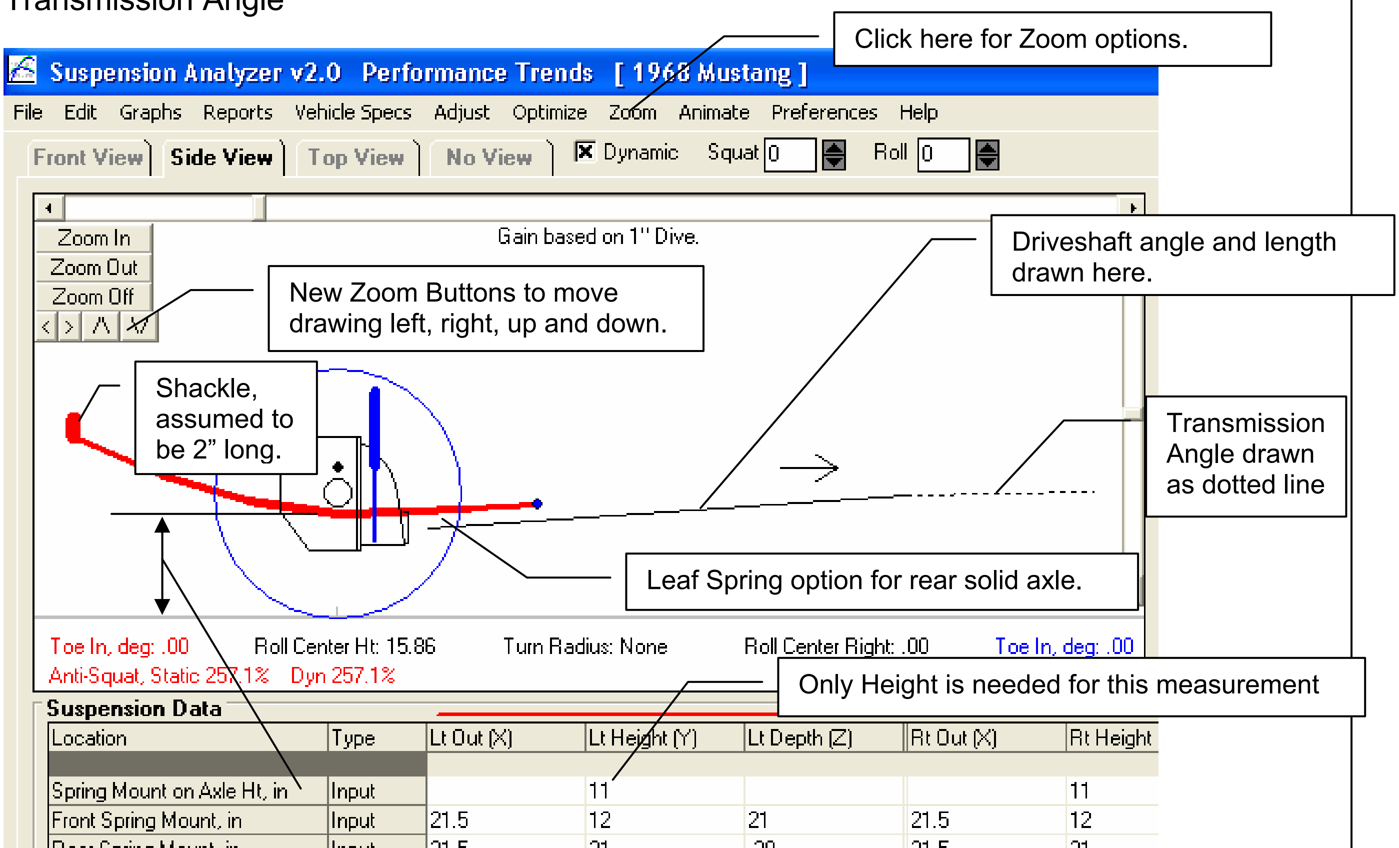


Leaf Springs, Zoom Features and Transmission Angle

Figure A 6.6 shows some additional new features in v2.0. Notes for leaf springs:

- Only the Height Measurement is needed for the Spring Mount on the Axle. The program will assume this is on a straight line between the front and rear mounting points.
- For the Rear Mount, use the location where the shackle mounts to the ***frame***, ***not*** where the shackle mounts to the leaf spring. The program will assume approximately a 2" shackle that is vertical at ride height. The rear end of the spring is not as critical as exactly where the shackle mounts to the frame.
- Because leaf springs are flat, they resist roll more that coil springs do at equal spacing. Most authorities say they have about 25% higher roll stiffness than the same suspension with coil springs or torsion bars. Figure A 6.1 shows where you can change this percentage based on your own experience.

Figure A 6.6 Showing New Rear Suspension Type (leaf springs), Zoom Features and drawn Transmission Angle

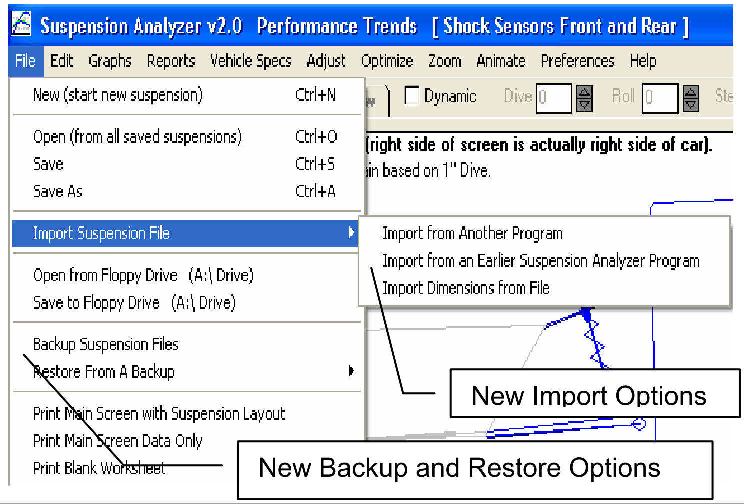


New File Options

Figure A 6.7 shows some new File options. The Backup command copies all suspension files to a floppy disk, CD or memory stick. Restore copies files from a previously backed up floppy disk, CD or memory stick back to your program. To be safe, before you restore, you may want to do a backup in case you restore "over the top of a file" which you have recently changed.

The Import Dimensions from File is only available in the Full Vehicle Version with Data Logger Features.

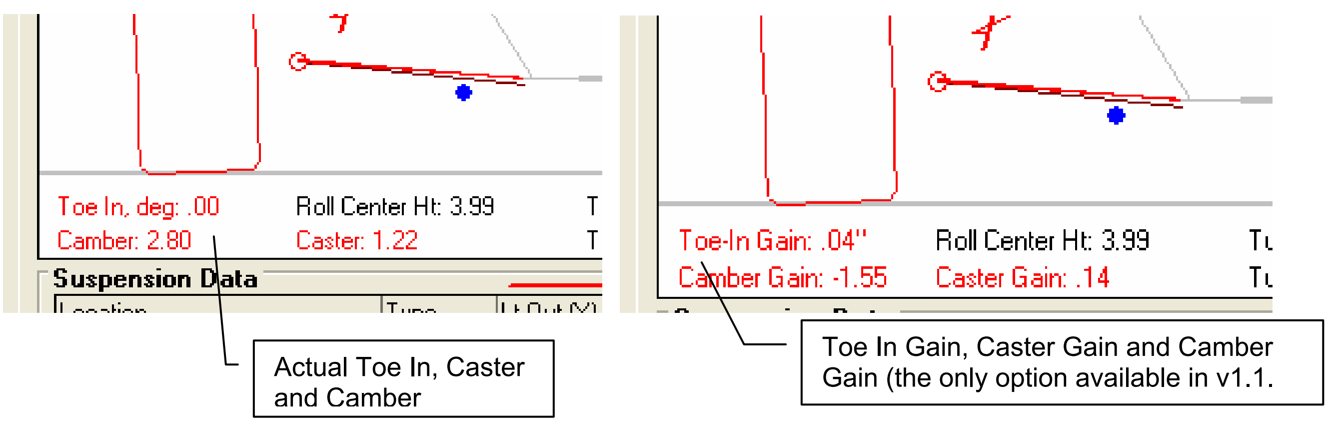
Figure A 6.7 New File Options



Preference to Show Toe Gain, Caster Gain and Camber Gain vs Actual Toe, Caster and Camber

Figure A 6.8 shows the difference for setting this preference, as shown in Figure A 6.2. Gains mean the amount of change for a given amount of vehicle movement, typically 1" of dive (or squat in the rear). Setting this to Actual Toe, Caster and Camber may be easier to understand for many users.

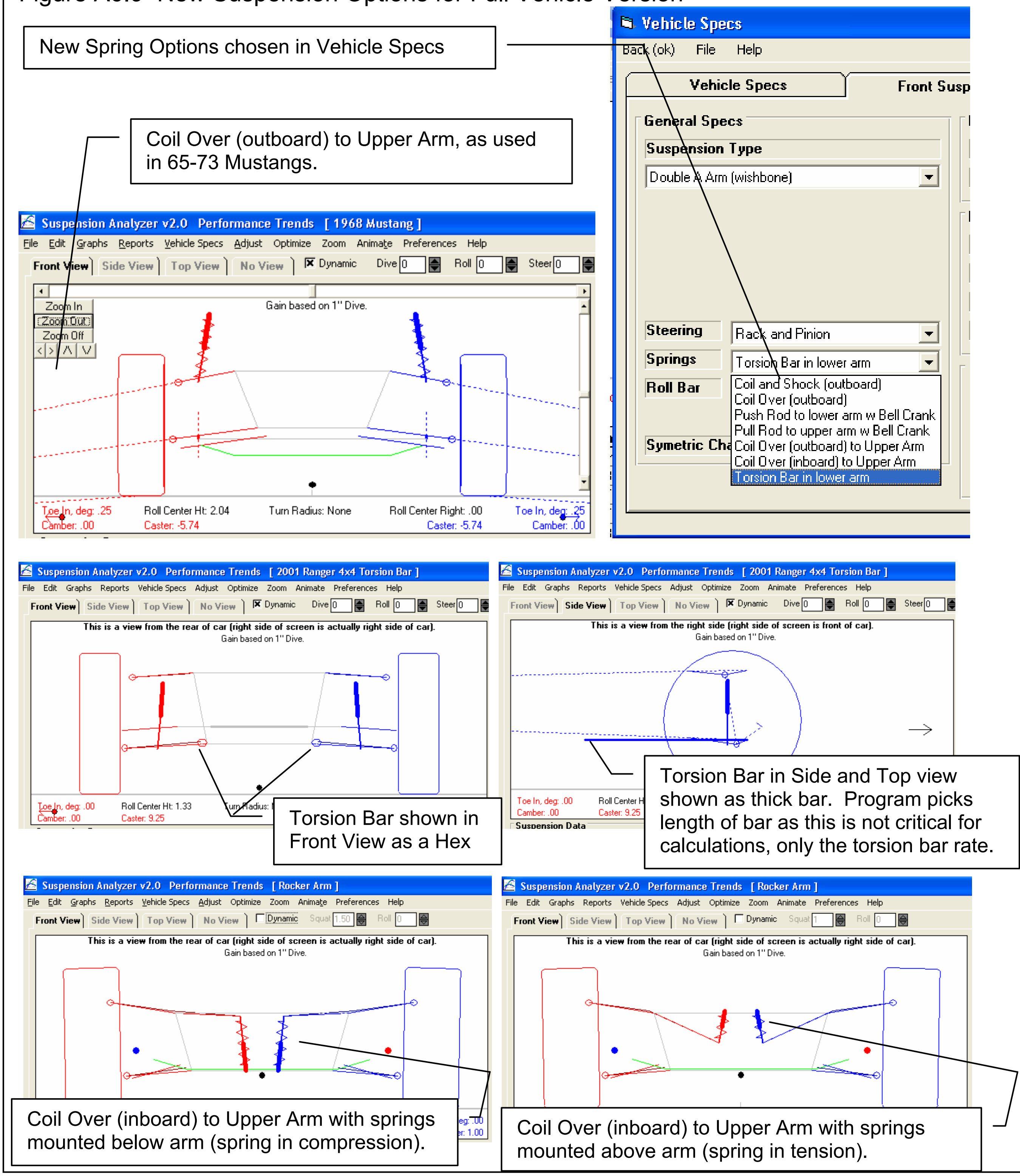
Figure A 6.8 Toe Gain, Caster Gain and Camber Gain vs Actual Toe, Caster and Camber



New Types of Springs

Figure A 6.9 shows some of the new types of springs possible in v2.0, the Full Vehicle Version. In addition, Leaf Spring solid axle is an option as shown in Figure A 6.7.

Figure A6.9 New Suspension Options for Full Vehicle Version



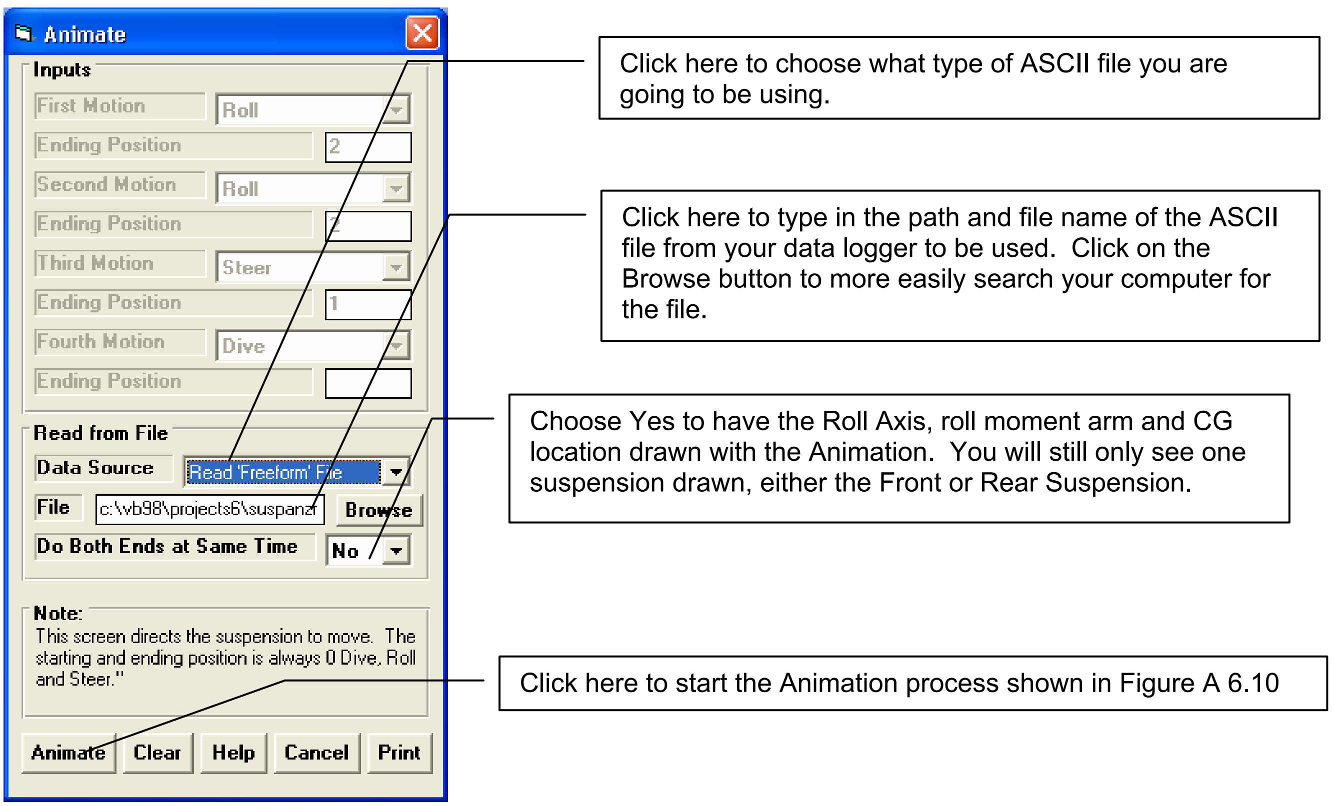
Full Vehicle Version with Data Logger Option

Animate Data Logger Data

The Suspension Analyzer can read ASCII files from data loggers recording engine RPM, vehicle speed, shock travel, etc and display the actual suspension movement for detailed analysis. This is done automatically with Performance Trends' DataMite II data logger, but can also be done with ASCII data from other data loggers. Figure A 6.11 shows the Animation screen when displaying this data logger data.

To start the Animation process, click on Animate at the top of the main screen. If you have purchased the Full Vehicle with Data Logger Options version, you will have a section called "Read from File" at the bottom of this screen. Figure A 6.10 explains some of these features. (See section 2.7 on page 49 for more basic explanation of the Animate feature.)

Figure A 6.10 Animate Menu of Options



There are 4 types of file formats the Suspension Analyzer can read, which can be picked in the Data Source input in the Animate screen, as described in Table A 6.1 below.

Table A 6.1 File Formats for Animate

Read from File (short)	This file would typically be for just the front suspension with minimal data channels recorded. Column 1 time Column 2 RF Shock Travel Column 3 LF Shock Travel Column 4 Steering Travel
Read from File (long)	This file would typically be for both the front suspension and rear suspension with minimal data channels recorded.

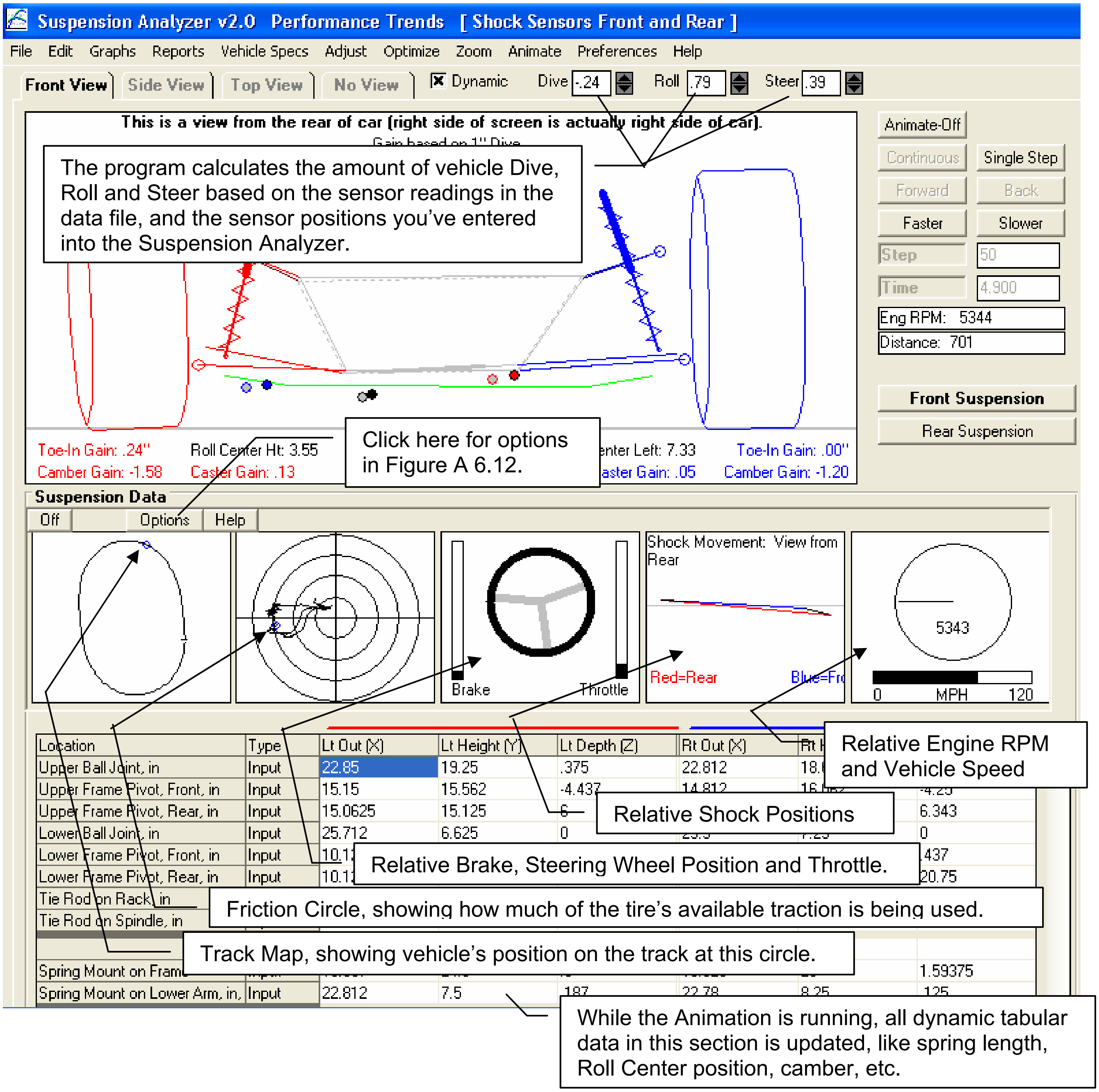
	Column 1 time Column 2 Engine RPM Column 3 distance along track from starting location Column 4 RF Shock Travel Column 5 LF Shock Travel Column 6 Steering Travel Column 7 RR Travel Column 8 LR Travel
Read from File w Track Map	This file is the same as what the Performance Trends DataMite II's software would export to the Suspension Analyzer. Most other data logger software packages do not export the Track Map feet data, so this form has been made easier to use with the addition of the Freeform format below. Column 1 time Column 2 track map feet to right (X direction) of starting location Column 3 track map feet forward (Y direction) of starting location Column 4 longitudinal gs, + is acceleration Column 5 lateral gs, + is accel to right (turning right) Column 6 distance along track from starting location Column 7 Engine RPM Column 8 MPH Column 9 RF Shock Travel Column 10 LF Shock Travel Column 11 Steering Travel Column 12 RR Travel Column 13 LR Travel Column 14 Brake pressure or Travel Column 15 Throttle Travel
Read 'Freeform' File	This file format can have the columns in any order and does NOT need the Track Map data. The Suspension Analyzer can generate it from the other data supplied. You do not need to provide all data columns. The program will just not display what you have not provided. This format was designed so that you could just export or write most any ASCII text file from your data logger of all your channels, and the Suspension Analyzer would just "handle it". If you have a data file which the program can not "handle", please email us a copy of it and we'll let you know what can be done. time longitudinal gs, + is acceleration lateral gs, + is accel to right (turning right) distance along track from starting location Engine RPM MPH RF Shock Travel LF Shock Travel Steering Travel RR Travel LR Travel Brake pressure or Travel Throttle Travel

Notes for the Freeform file format:

- The data must be for only 1 lap.
- If the data file includes data at more than 1 sample every 0.1 seconds, the program will ignore points which were recorded faster than 0.1 seconds, and only use points at approximately every 0.1 seconds.
- The columns must each have a text name so the program can determine what they are.
- Columns can be separated either by commas or tabs.

Example files of each of these file formats can be found in the Data Logger Files folder in the Suspension Analyzer folder "SuspAnzr20".

Figure A 6.11 Animate Feature Using ASCII Text Data Exported from Data Logger

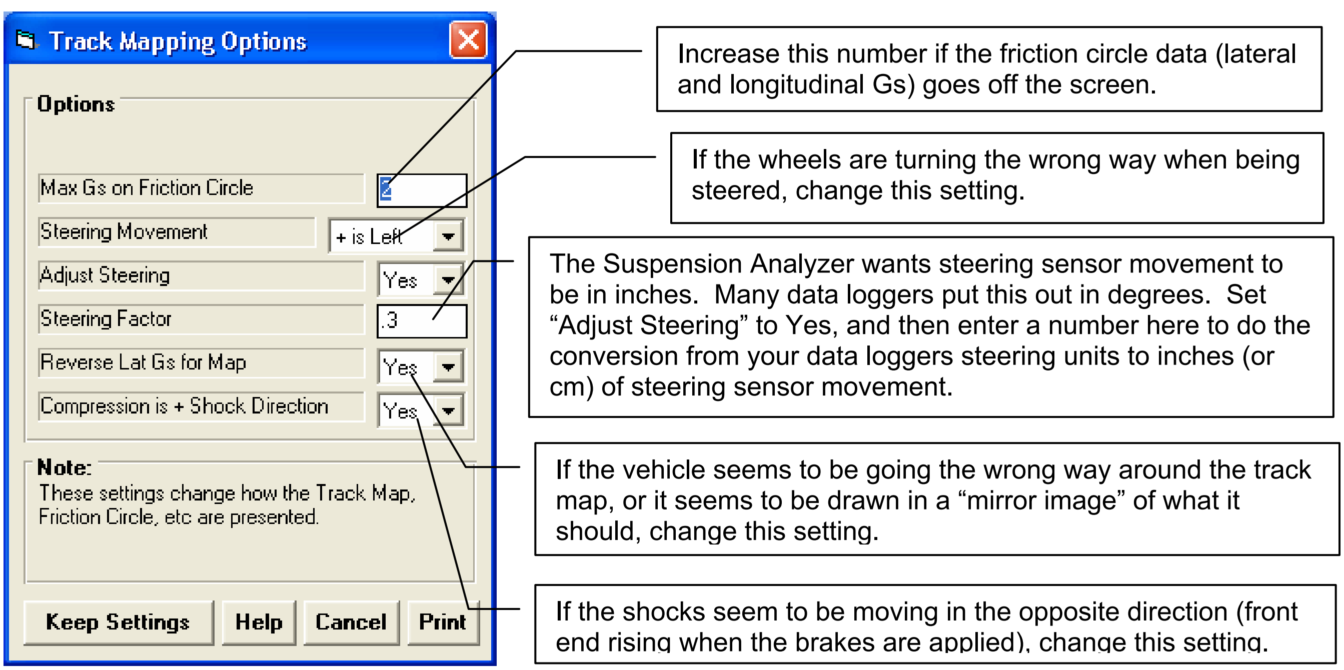


The 5 sections at the bottom of the graph consist of, from right to left, as identified in Table A 6.2.

Table A 6.2 Graph Track Map Sections

1	Track Map	The Track Map is a simplified drawing of the track layout. If you click on a point on the map, then the circular "cursor" identifying that point is drawn on the map. At the same time, a corresponding "cursor" is drawn on the Friction Circle for the same point, and the suspension movement for that position is displayed.
2	Friction Circle	The Friction Circle is a graph of the sum of the lateral and longitudinal acceleration the vehicle is exhibiting. If you click on a point on the friction circle, then the circular "cursor" identifying that point is drawn on the friction circle. At the same time, a corresponding "cursor" is drawn on the Track Map for the same point, and the suspension movement for that position is displayed.
3	Steering, Throttle, Brake	This section shows the relative brake, throttle and steering wheel position and motion. These signals are what ever you have assigned as "Brake", "Throttle" and "Steering" in the DataMite specs. If the steering wheel's motion seems to be opposite of what the actual motion is, then click on the Options button and you can change it. See the explanation below. The term "relative" is used because before this section is drawn, the program finds both the maximum and minimum values for the brake, throttle and steering channels. Then the program "auto-scales" these 2 bar graphs and the steering wheel motion to show good resolution of this movement.
4	Shock Movement	This section shows the relative position and motion of the shock sensors. These signals are what ever you have assigned as "RF Shock", "LF Shock", "RR Shock" and "LR Shock" in the DataMite specs. The assumption for this display is that as the Shock Signal gets larger, that the shock is extending (getting longer). The Red line connects the 2 rear shocks. This is a rear view of the car and this line is drawn with a longer line to simulate it is closer to the viewer. The 2 front shocks are connected with a shorter, blue line. This section is good to visualizing general trends, but much more detailed results are available with the other Animate features.
5	Engine RPM, MPH	This section shows relative engine RPM on the Tach Gauge and relative vehicle speed on the bar graph.

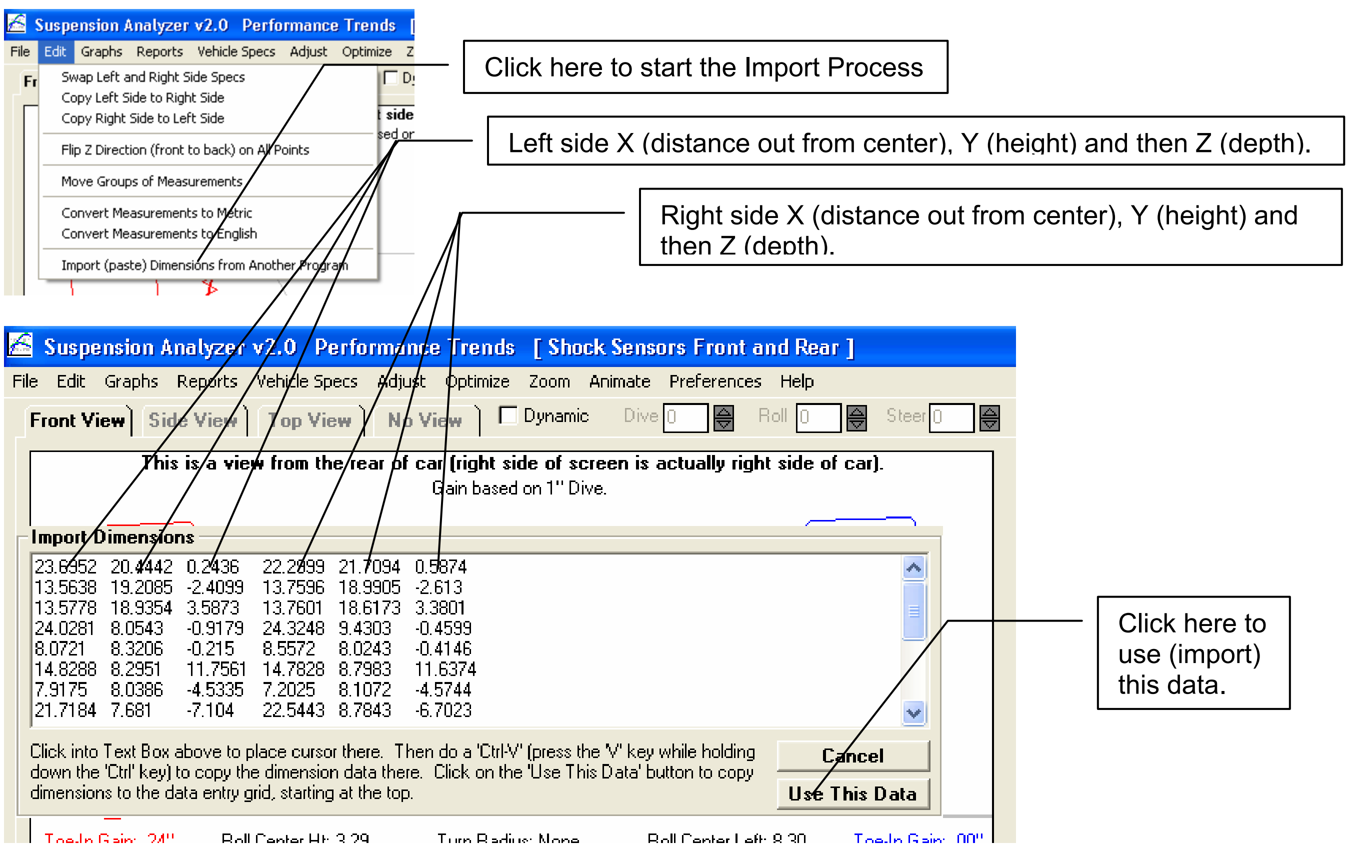
Figure A 6.12 Track Mapping Options



Import Dimensions

Some users use CAD programs for designing their suspensions, and needed an easy way to input several measurements quickly to the Suspension Analyzer program. Figure A 6.2 shows the command to import these dimensions from an ASCII file. Figure A 6.13 below shows how to do this by copying the data from a program (like Excel using the Ctrl-C command). Then you will paste it into the Suspension Analyzer's Import Dimensions screen by clicking on the Import window, then using the Ctrl-V command (press and release the letter V key while holding down the Ctrl key).

Figure A 6.13 Importing Dimensions by Direct Copying from Another Program



The Suspension Analyzer can read suspension measurements copied from other programs, either tab separated or comma separated. The format is one row of 6 measurements for every row available for data entry on the current screen, either front or rear suspension. The data in the row is expected to be Left Side X, Y and Z, then Right Side X, Y, Z.

Notes:

- If your Preference settings are such that you are using a Front view in your Suspension Layout, the screen will display the Right side measurements in the left columns, then the Left side measurements. Even in this situation, you still have the Left side measurements come first when importing.
- If Left Side X values are negative (common in some CAD programs), they will be converted to + in the import process.
- You will make a large change to your existing Suspension File. If you have not saved a copy of this suspension's current measurements, you may want to choose 'Cancel' at the next screen to Stop Importing these dimensions. Then you can save your current settings should you want to return to them if the Import process does not work as you intended.