Suspension Analyzer

Full Vehicle Version

Overview of Features

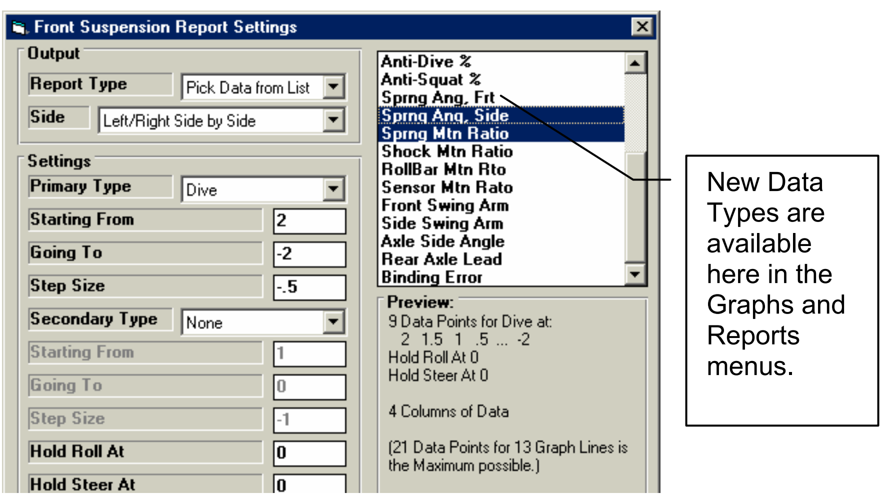
The Full Vehicle version of Suspension Analyzer has several enhancements over the standard version, the most significant is analyzing various types of rear suspensions and combining front and rear suspensions together for full vehicle analysis. A list of the Full Vehicle version's features includes:

The Full Vehicle Version lets you graph or report these additional types of data.

Anti-Squat %	Sprng Ang, Frt	Sprng Ang, Side
Sprng Mtn Ratio	Shock Mtn Ratio	RollBar Mtn Rto
Sensor Mtn Rato	Front Swing Arm	Side Swing Arm
Axle Side Angle	Rear Axle Lead	Binding Error (for solid axles and 5 link independent)
FLLD% (front lateral load distribution, a handling rating)		

These data types are added to the bottom of the Data List in the Graph and Report menu.

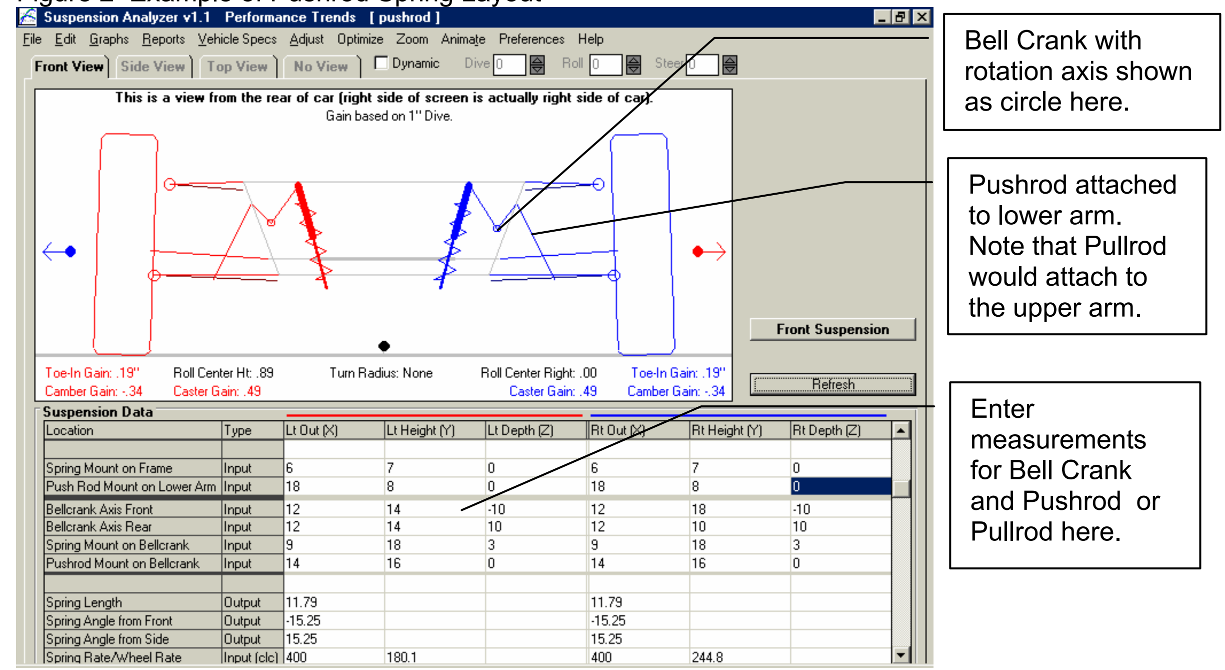
Figure 1



These data are displayed on the Main Screen in the Data Grid. For a complete listing of these inputs and calculated outputs, click on Help at the top of the Main Screen, then List Definitions for Main Screen Input/Output.

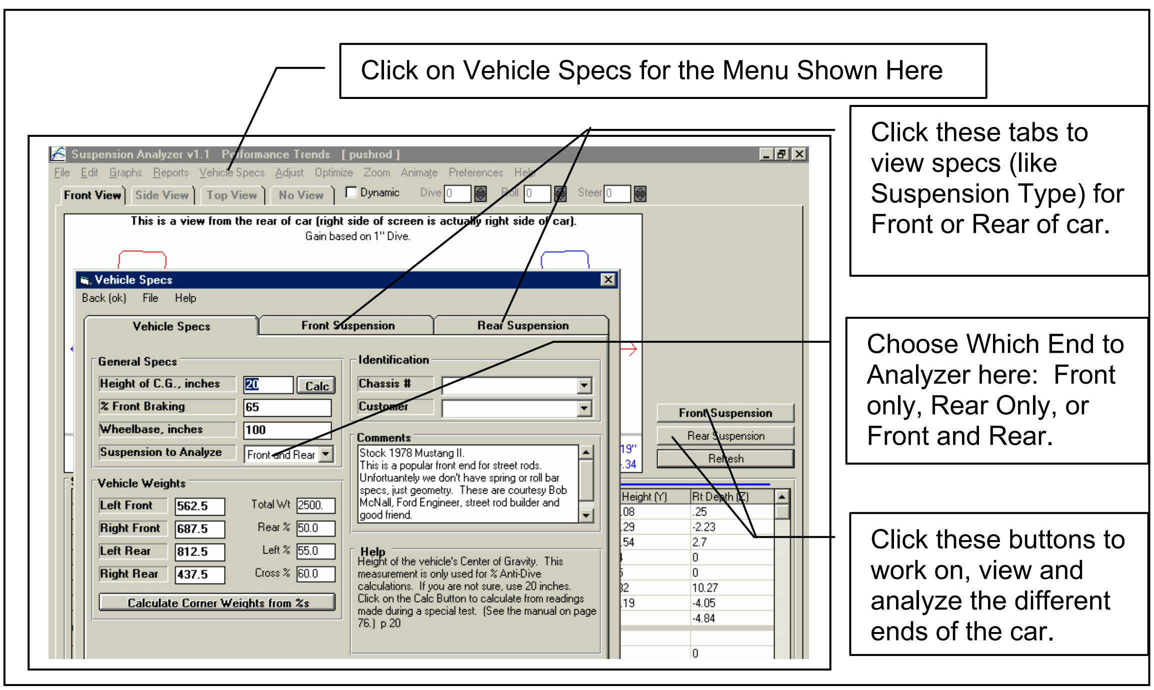
The Full Vehicle Version lets you specify Push Rod w Rocker Arm and Pull Rod w Rocker Arm springs for Double A Arm suspensions. In Vehicle Specs, choose these types for the "Springs" spec.

Figure 2 Example of Pushrod Spring Layout



Full Vehicle Version lets you analyze these ends of the car.

Front Suspension Only	Rear Suspension Only
Front and Rear Suspension together	

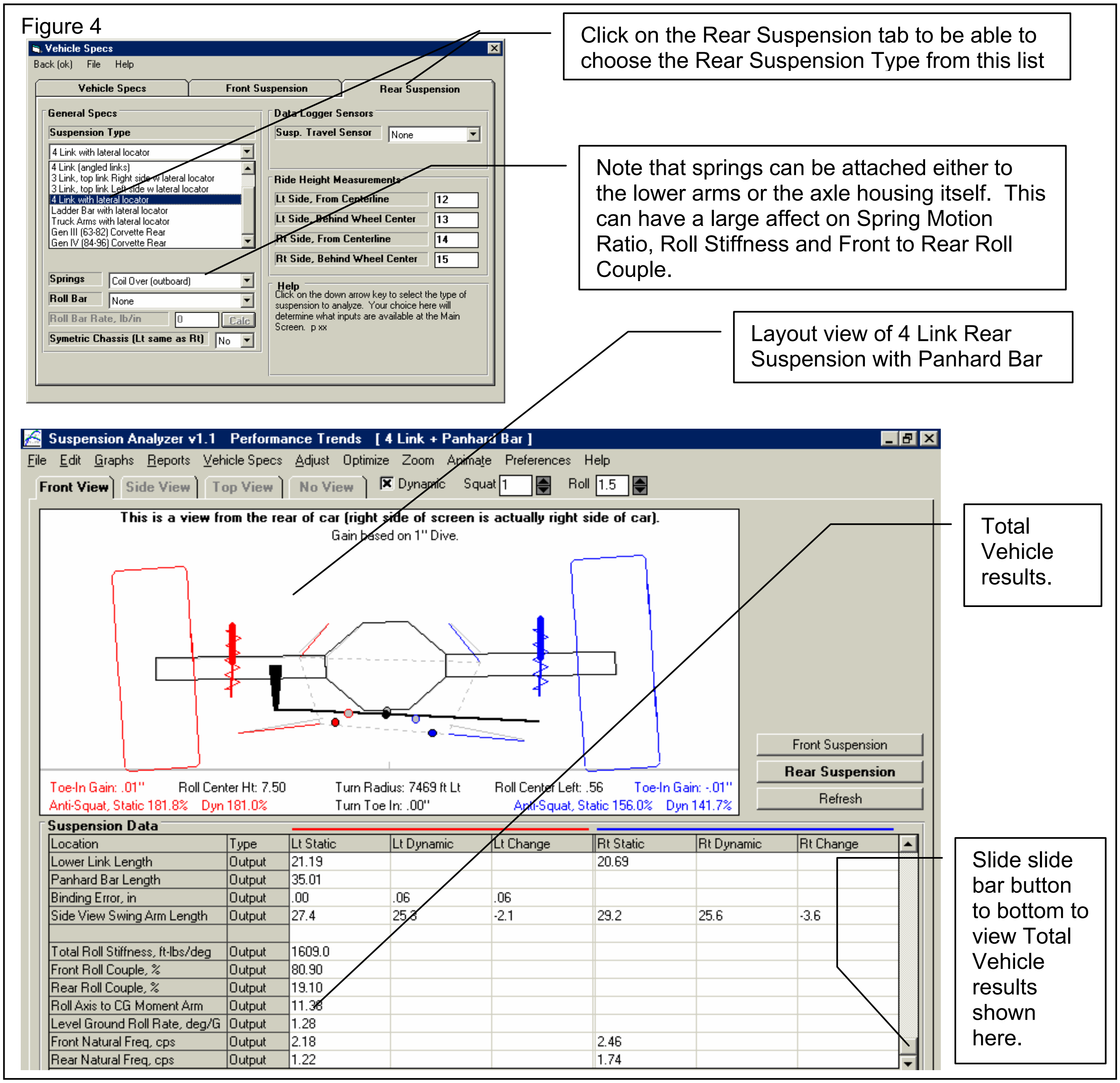


To graph or report data for a particular end of the car, you must have chosen to view that end of the car on the main screen by clicking on the appropriate button at the lower right of the layout screen.

The Rear Suspension Types supported at this time include are given below.

Double A Arm	McPhearson Strut
Three Link w panhard bar	Four Link (angled links like Chevelle or 5.0L Mustang)
Four Link w panhard bar	Ladder Bars (trailing arms)
NASCAR Truck Arms	C3 Corvette (63-82)
Torque Tube Live Axle	5 Link Independent (like C4 Corvette)
Torque Arm Live Axle	Trailing Arm and Semi Trailing Arm
Leaf Spring Live Axle	Decoupled (bird cage) Live Axle
	H Arm Independent (like IRS Thunderbirds and Cobra Mustangs)

Figure 4

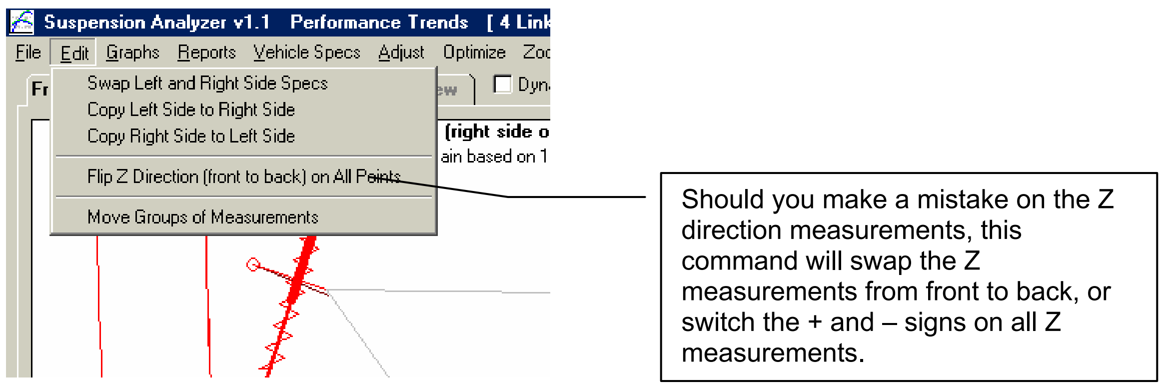


If you analyze Front and Rear Suspension together, the program also calculates and displays these Full Vehicle results.   These results are listed at the bottom of the Data Table on the main screen.

Total Roll Stiffness, ft-lbs/deg	Front Roll Couple, % (a handling rating)
Rear Roll Couple, % (a handling rating)	Roll Axis to CG Moment Arm
Level Ground Roll Rate, deg/G	Front Natural Freq, cps
Rear Natural Freq, cps	FLLD% (front lateral load distribution, a handling rating)

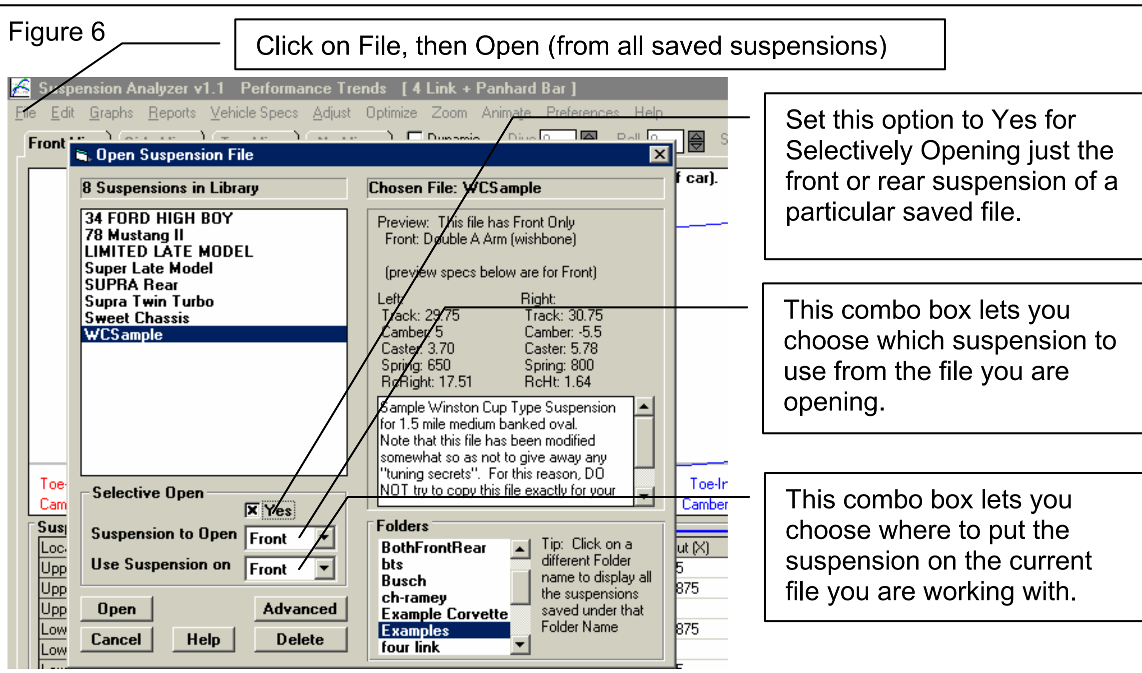
The Depth (Z) measurements for Rear Suspensions are positive if they are in front of the axle, toward the front of the car. Depth (Z) for both the front and rear mean “in towards the center of the car”. See Figure 5 if you’ve made a mistake entering Z measurements.

Figure 5



Another useful feature for working with front and/or rear suspensions is the ability to “selectively open” one end of a vehicle suspension file and use it on the same end of the current vehicle you are working with or building. For example, say you have built a vehicle file working with only the Front Suspension file. Now you want to put only that front suspension on an existing vehicle file which has both a front and rear, but you want to keep the rear. You would click on File, then Open, then choose the Selective Open option shown in Figure 6. This feature also lets you put a front suspension on the rear or rear suspension on the front (McPhearson Strut or Double A Arm only).

Figure 6



Version 1.1 C.017, Feb 4, 2002 added a new type of rear suspension type, the IRS with lower H arm, typical of that used in the IRS Ford Thunderbirds in 1987 and the Cobra Mustangs. See Figures 7 and 8 below.

Figure 7 Independent Rear Suspension (IRS) with Lower H Arm

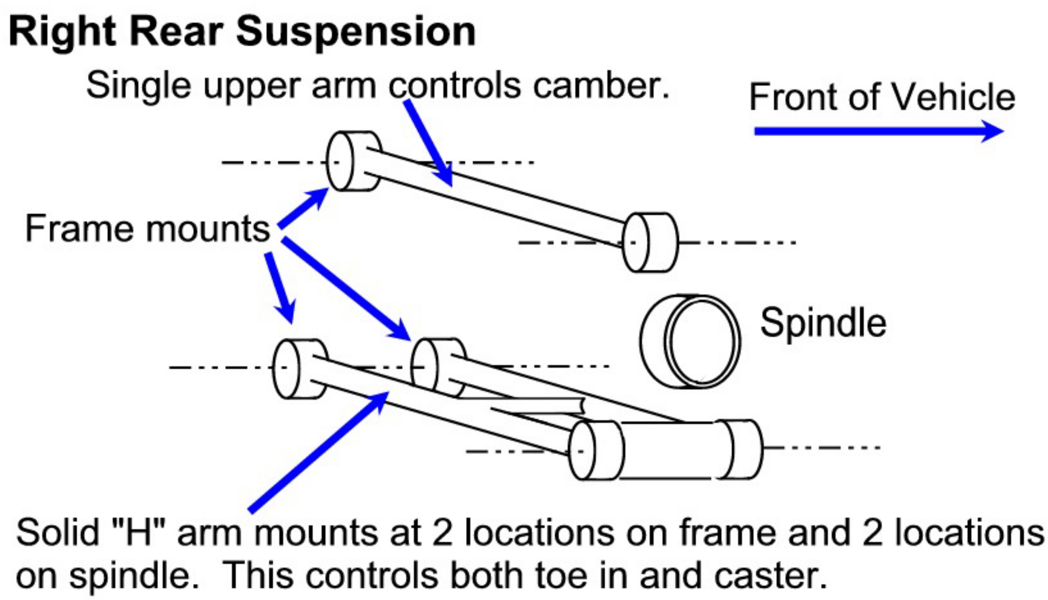
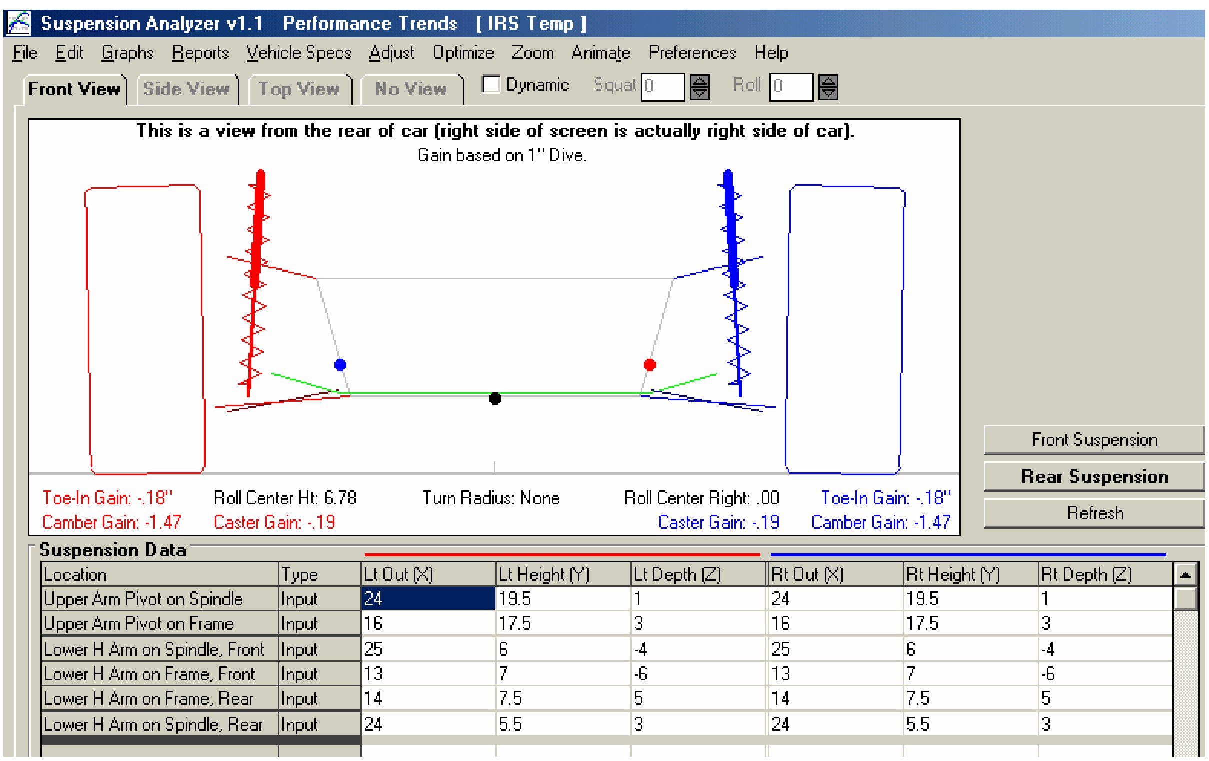


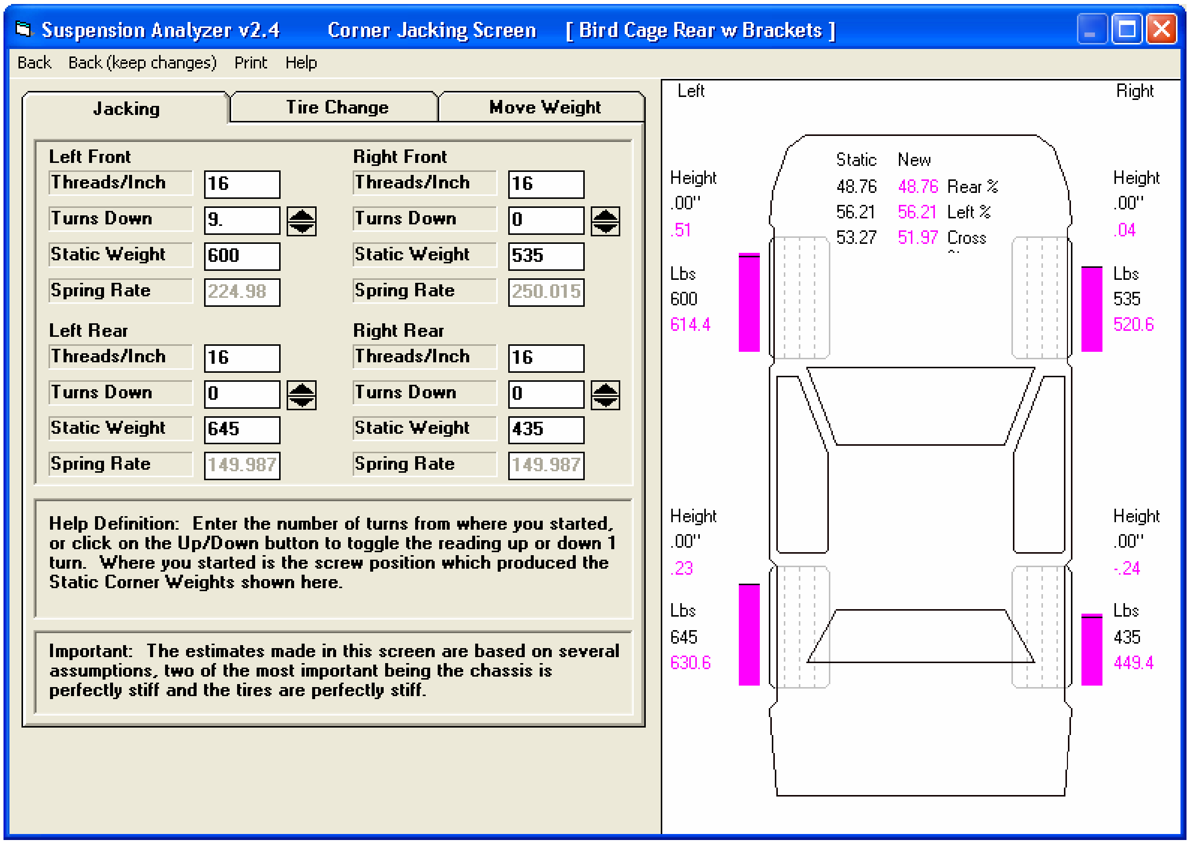
Figure 8 Data Input Screen for IRS Rear Suspension Type



Location	Type	Lt Out (X)	Lt Height (Y)	Lt Depth (Z)	Rt Out (X)	Rt Height (Y)	Rt Depth (Z)
Upper Arm Pivot on Spindle	Input	24	19.5	1	24	19.5	1
Upper Arm Pivot on Frame	Input	16	17.5	3	16	17.5	3
Lower H Arm on Spindle, Front	Input	25	6	-4	25	6	-4
Lower H Arm on Frame, Front	Input	13	7	-6	13	7	-6
Lower H Arm on Frame, Rear	Input	14	7.5	5	14	7.5	5
Lower H Arm on Spindle, Rear	Input	24	5.5	3	24	5.5	3

The Virtual Scales feature shown in Figure 9 lets you change certain vehicle specs and see the effect on Corner Weights.

Figure 9 Virtual Scales



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

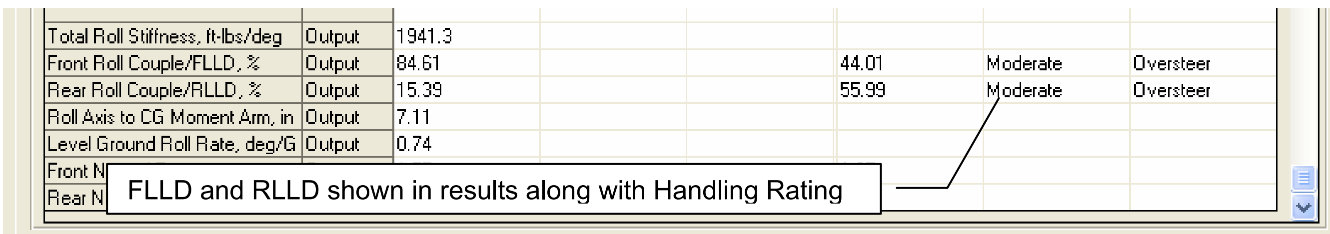
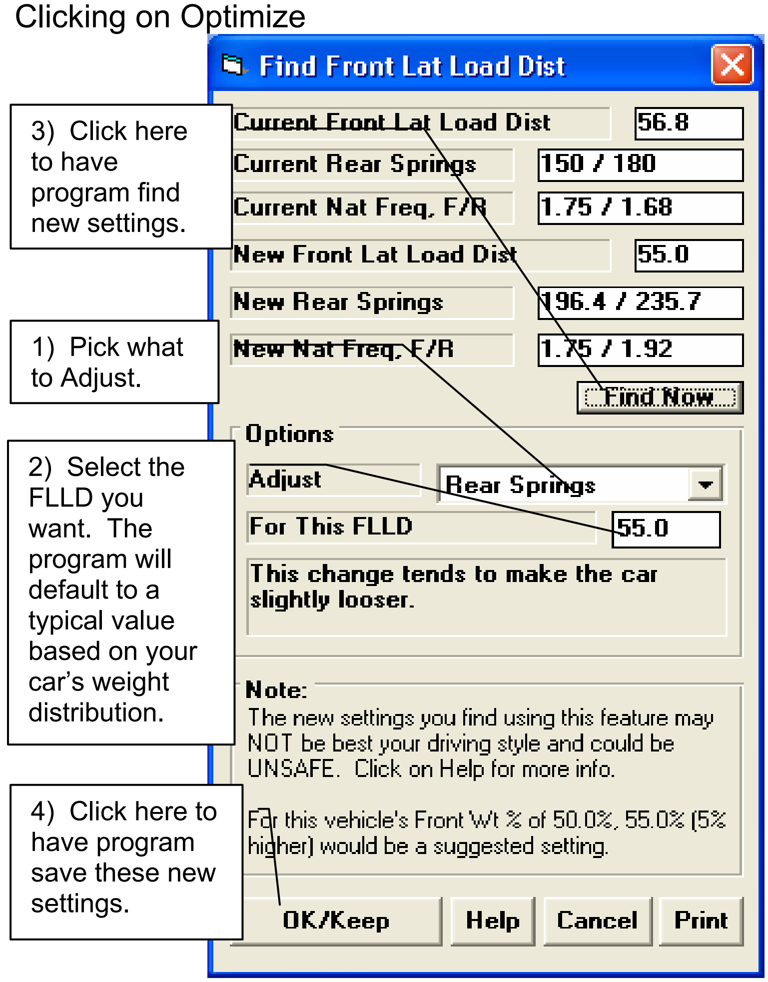


Figure A6.3 is displayed if you click on the "Find" button shown in Figure A6.2. This "Find FLLD" screen lets you find a certain Front Lateral Load Distribution (FLLD), which can be a good indication of how the car will handle at the apex or transistion of the turn (no power, no braking).

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.

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



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.

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.

See **Appendix 6, New Features in v2.0** and **Appendix 7, New Features in v2.4** to see all the new types of rear suspension geometries which can be simulated in the Full Vehicle version.

Torque Tube Live Axle	5 Link Independent (like C4 Corvette)
Torque Arm Live Axle	Trailing Arm and Semi Trailing Arm
Leaf Spring Live Axle	Decoupled (bird cage) Live Axle
	H Arm Independent (like IRS Thunderbirds and Cobra Mustangs)