

Appendix 9 New Features in v2.4 C

Version 2.4C adds several features, which include:

New Suspension Types or Options

Roll Center for Double A Arm and McPherson Strut suspensions are now calculate using the Force Based Roll Center methodology. This method is more accurate and realistic. You will no longer see roll centers being calculated, say, 50 or 1000 inches beyond the track of the car, which made very little sense. There is a Preference Setting which lets you revert back to the old “Kinematic” method of calculating Roll Center, which was what we did before this new v2.4C. Figs A 6.50 and A 6.51.

De Dion rear suspension is now one of the Rear Suspension Types you can choose from. The De Dion is somewhat of a hybrid. It is like a independent rear suspension in that the differential or transaxle is mounted to the chasses, eliminating unsprung weight. But for suspension geometry, it is like a solid axle (live axle). There is a beam that solidly connects the wheel spindles on right and left. Fig A 6.52.

You can now specify a Jacob’s Ladder as a possible “lateral locator” for solid axle suspensions. Fig A 6.53.

Now if you specify either end of the car as having traction (driving tires) and the suspension type is independent, fields open up for you to enter the location of the center’s of the CV or U joints. The program will calculate the length of the half shafts connecting these 2 joints. Then when you have the suspension go through motion, the program will calculate how much the length changes. Note: You can not choose to use Push or Pull Rod suspension types to be able to specify CV joints. Figs A 6.54 and A 6.55.

New History Log Feature

We have added a “History Log” to the ways of opening a file. The History remembers the last 100 files you have been working with. The number of files saved is selectable in the Preferences menu. This can be a very handy to be able to go back and see what files you have been working with. Fig A 6.56.

Click on File, then Open from History Log at the Main Screen to obtain the History Log shown below in Figure 3.37. This screen shows a summary of the results for the last 100 tests you have worked with (started new, opened, graphed, etc.) When you work with a new test, it is added to the top of the History Log, and (if the Log is full) the last run drops off the bottom of the list. The History Log is an alternate way to Open tests which have been saved to the Test Library. The advantage of the History Log is it lists the tests you most recently worked with at the top, making them easier to find. Fig A 6.56.

Suspension File and Path Click on Suspension File and Path and you are asked if you want to retrieve the file which produced these results. Fig A 6.56.

Graph? Choose to Graph certain files by clicking on the “Graph ?” column to insert a Yes there. Click on an existing “Yes” to remove it. Files marked Yes to Graph will be graphed when you click on the “Graph Tests Marked 'Yes'”. The first file (usually the current file you are working with) is always graphed even with no Yes marked. The number of files actually graphed is limited by available space, usually a limit of about 40 graph lines total. Figs A 6.56 and A 6.57.

Std Graph Title Click on “Std Graph Title” to change the Standard Title for this file. The program will default to the file name, but you can change it to most anything you want. (You can also specify 'Alternate' titles and legend names by clicking on 'Format' at the top of the Graph Screen, then “Edit Printed Comments and Data Output”.) Figs A 6.56 and A 6.57.

Save? Choose to Save certain Files to the History Log by clicking on the Save column to insert a Yes there. Files marked Yes to Save move to the bottom of the History Log as more runs are made, but will not fall off the History Log. NOTE: If a file falls off the History Log, it is not deleted. You just have to open it via File, then Open, or add to a graph via Add Suspension. Fig A 6.57.

Front Suspension / Rear Suspension These columns show the type of suspension for each end of the vehicle.

History Log Commands

Graph Tests marked 'Yes' Click this to close the History Log and graph all files with a Yes in the "Graph ?" column.

Graph Current Test Only Click this to close the History Log and graph only the first test in the History Log, which is the file you are working with on the main screen.

Clear (erase History Log) Click this to erase all files out of the History log except those with a Yes in the "Save?" column or the current file in the top row.

Print You can print the History Log on a printer by clicking on the 'Print' menu command. Note that the printed History Log will be most readable when the Page Orientation is in Landscape setting.

Note that just the Test File Name stays in the History Log. Should you delete the file using the Open (from all saved tests) command, the test file will be deleted but the name will stay in the History Log. When you try to open it or graph if from the History Log, you will get note saying the file can not be found.

New Spring and Shock Calculations

The program now has screens for entering Shock Dyno data. Click on Vehicle Specs, then Shock Data for this screen. If you have Performance Trends' Shock Dyno software, there is a "Send" feature to automatically send shock dyno data to your computer's "clip board". Then in the Suspension Analyzer's Shock Dyno screen, click on the "Load from Shock Dyno" command and you can paste the shock dyno data into this screen. Figs A 6.58 and A 6.59 and A 6.60.

The program now displays the spring, bump spring and anti-roll bar forces as the suspension goes through dive, roll, steer and pitch. In addition, there is a new Shock Velocity input field, where you can enter a shock velocity. If you have also entered Shock Data, it will also calculate the shock force for this velocity. NOTE: When the shock is compressing, this is considered a negative velocity (shock getting smaller), and when the shock is extending this is considered a positive velocity. Other company's software may consider these velocities differently. Fig A 6.61.

If you run a screen animation, the Animate screen now has a Segment Time input. This time along with the motion for that segment lets the program calculate a shock velocity. For example, if the Segment is for 2" of Dive and the Segment Time is 1 second, then vehicle's dive velocity will be 2"/second. Depending on the shock's motion ratio, that could be, say, 1.5"/second. Everything being the same, if you had entered a Time Segment of 0.2 seconds, the velocity would be 7.5"/second. Fig A 6.62.

If you have imported Data Logger data to the Suspension Analyzer and do an Animation, the program will calculate the Shock Velocity from the Data Logger data. It will be displayed in the Shock Velocity field, and below it will be the Shock Force for that velocity, based on the Shock Dyno data you have entered. NOTE: The most accurate Shock Velocity and Force data is calculated when the program has calculated the shock's position both previous and after the current position. Therefore, until the program has gone through a complete lap of your Data Logger data, the shock data is a less accurate estimate based on the current shock position and the previous shock position (not the next shock position). Data Logger Version Only. Figs A 6.62 and A 6.63.

The program will also change the Handling Rating based on the Shock Force resulting from the Shock Velocity data entered.

Because the Shock Absorber features are involved and can produce unexpected results if you are not aware of what you are doing, there is a Preference setting to turn them On and Off. The default is the Shock Absorber inputs are turned Off. Turn them On in Preferences. Figs A 6.51 and A 6.58.

New Ball Joint Bind Feature (Data Logger Version Only)

The advanced Data Logger version of the program now lets you enter the Ball Joint Angle. This is the angle between ball joint stud position and position of ball joint stud when perfectly centered, perfectly vertical with respect to the ball joint. The program will then calculate the angle change of the ball joint stud as the suspension goes through motion. You can also enter a Max Ball Joint Angle. If the program calculates that the Ball Joint Angle exceeds the Max Ball Joint Angle, it will report this condition as Ball Joint Bind. It will also calculate Ball Joint Bind which is the amount the Ball Joint Angle has exceeded the Max Ball Joint Angle. Fig A 6.68 and A 6.71.

There is a Calculation screen utility to help you determine the Ball Joint Angle at ride height. The program knows the Spindle Angle from the ball joint locations. It asks you to enter the Ball Joint Flange Angle, which is the angle of the ball joint body with respect to horizontal. This can be found by placing an inclinometer (angle finder) on any flat part of the ball joint. Fig A 6.68 and A 6.69.

You can Graph or Report either Ball Joint Angle or Ball Joint Bind Angle. Ball Joint Bind Angle will be zero until the Ball Joint Angle exceeds Max Ball Joint Angle. Then this angle will be the angle amount Ball Joint Angle has exceeded Max Ball Joint Angle. If Max Ball Joint Angle is 25 degrees and Ball Joint Angle is 28 degrees, Ball Joint Bind Angle will be 3 degrees. Fig A 6.70 and A 6.71.

Other New Program Features

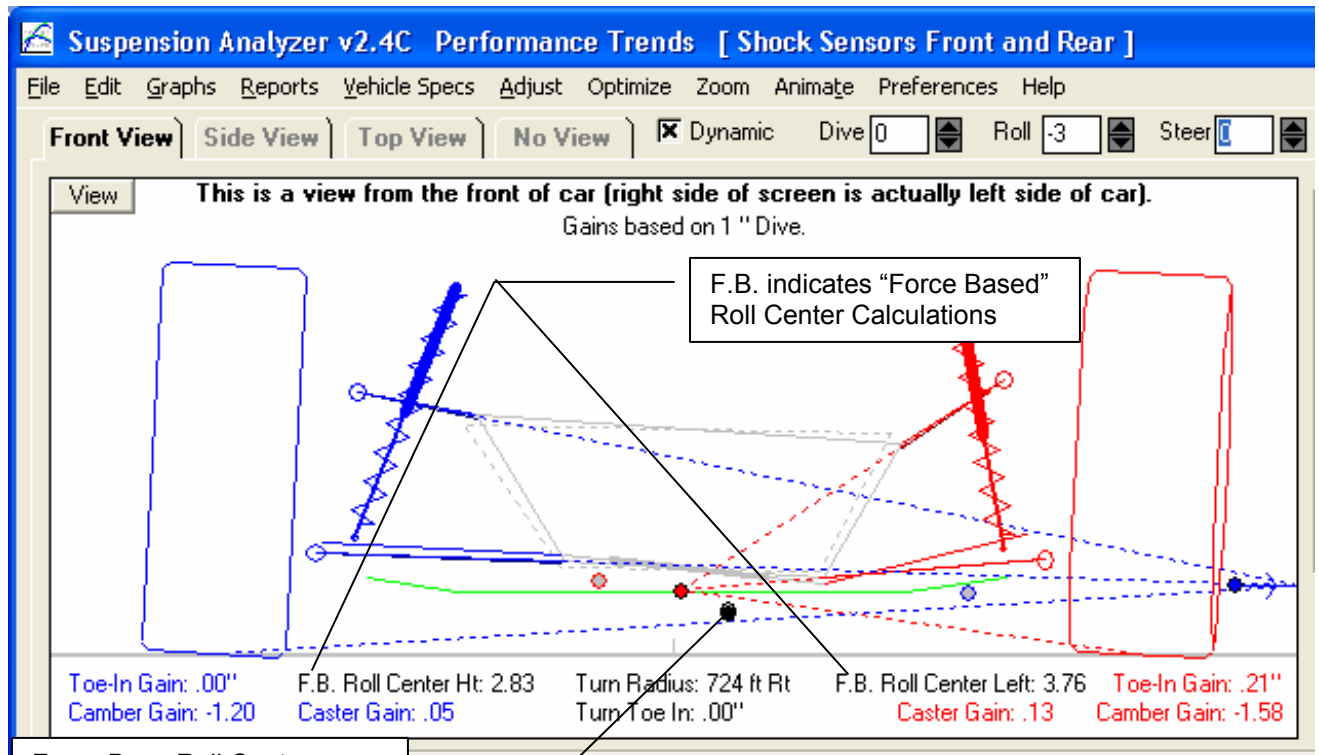
Under the “View” list of options, a new choice of Watch Rows has been added. Here you can specify from 0 to 6 rows of calculated data for you to “watch”. These rows are listed directly below the suspension drawing so they will always appear in the same place. This way you do not have to scroll through results for the data you are interested in. You can choose to have different rows “watched” on the front and rear suspension screens. Fig A 6.64.

We have added more options and accuracy to the Anti-Roll Bar Rate Calculator utility. Figs A 6.65 and A 6.66. These include:

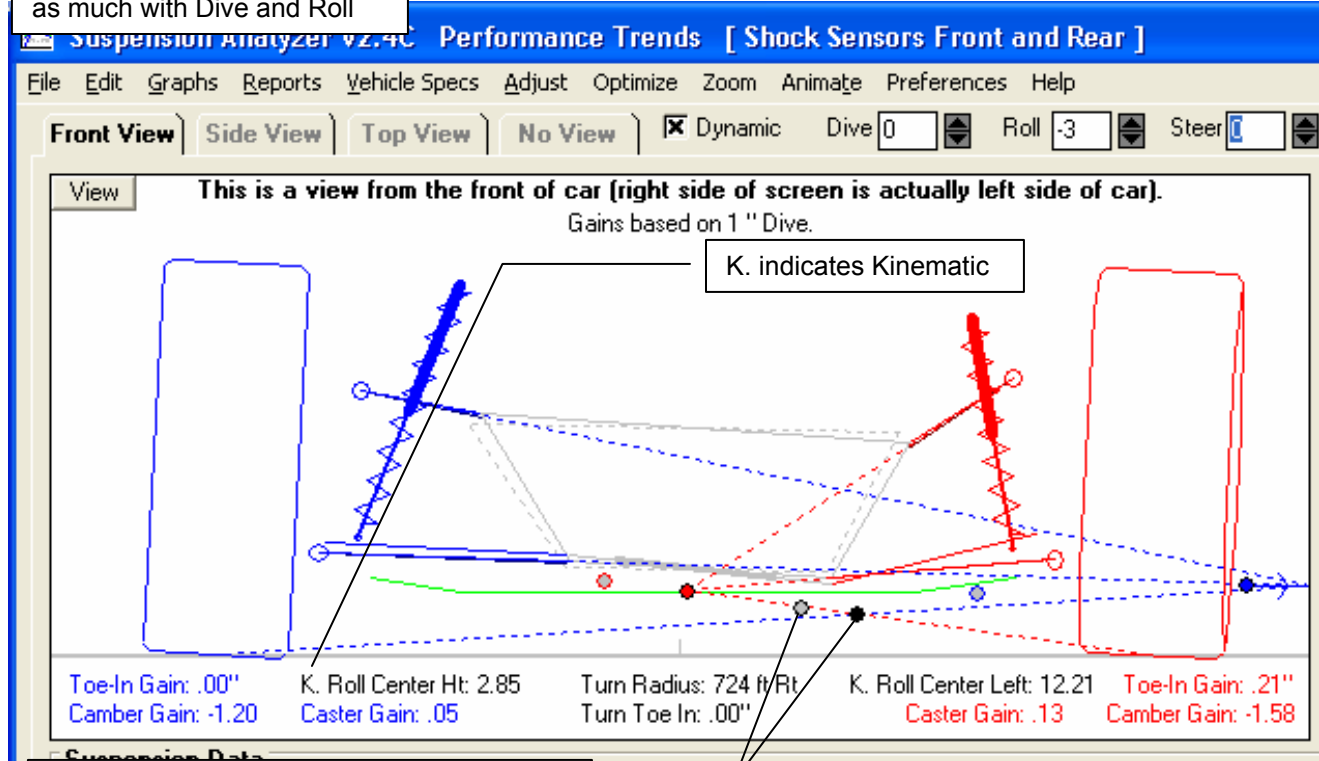
- Taking the flex of the bars connected to the suspension members on the end of the Anti-Roll Bars into account. This detail can significantly soften up the bar’s overall spring rate.
- Adding a feature to estimate a “blade” or “sword” anti-roll bar. This type of bar has a connector link that is very thin. The flex on this connector link will significantly soften up the bar. However, this connector link can be turned so it becomes less flexible, significantly raising the bar’s overall spring rate.

When opening files, there is a new option for “List by Access Date”, in addition to the original “List by File Name” which lists the files alphabetically. List by Access Date is a chronological list, where the files you most recently worked with are listed at the top, with the date you last opened them. Figs A 6.67.

Figure A 6.50 New Force Based Roll Centers

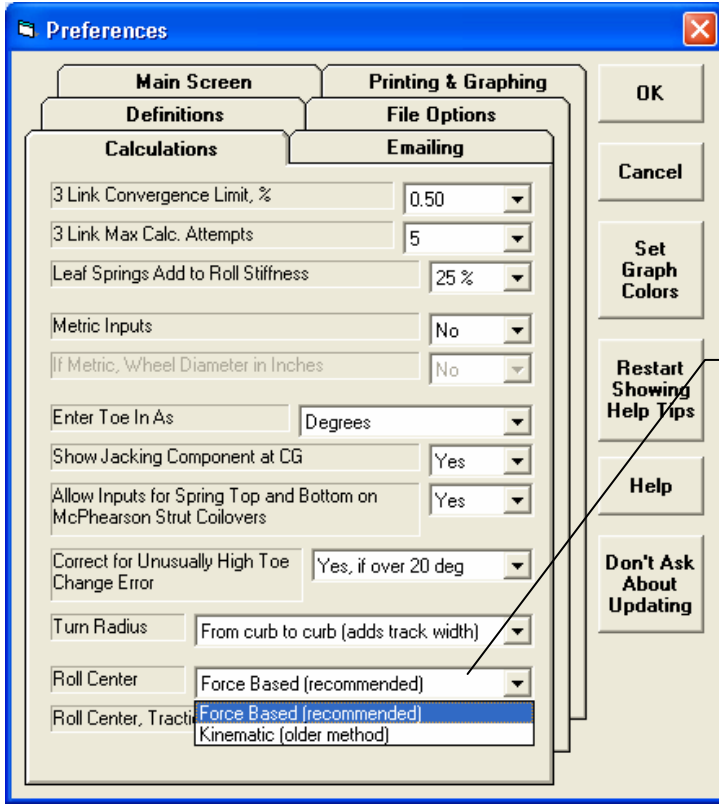


Force Base Roll Centers typically do not move around as much with Dive and Roll

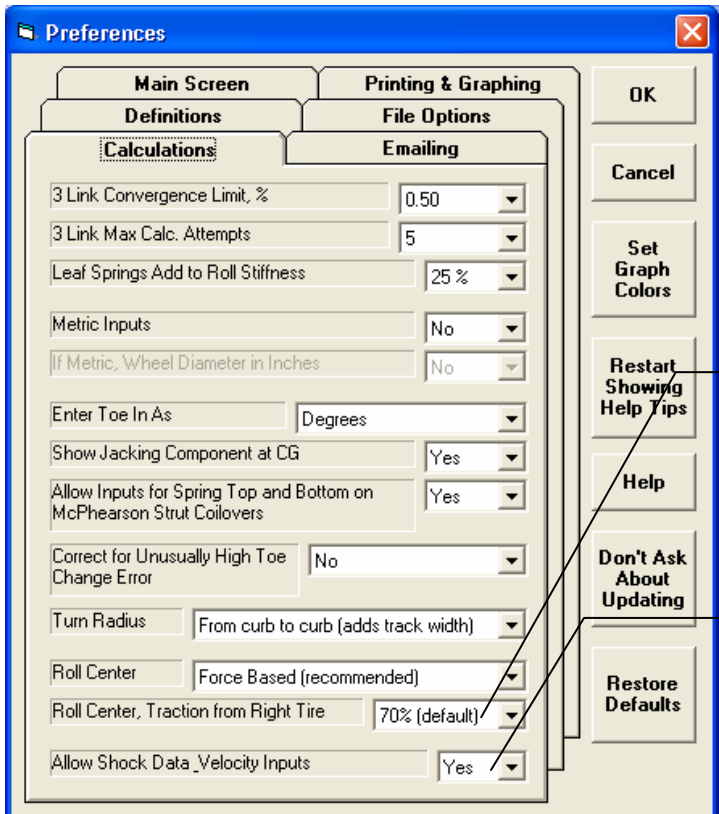


Kinematic Roll Center moves left as suspension goes through -3 degrees of roll.

Figure A 6.51 New Preferences: Force Based Roll Centers and Shock Data Analysis



Pick method here



If you pick Force Based, you must specify how much traction is coming from the outside tire in a turn. 70% is a good assumption for most situations.

New Preference to all Shock Data to be entered and analyzed.

Figure A 6.52 Di Dion Rear Suspension

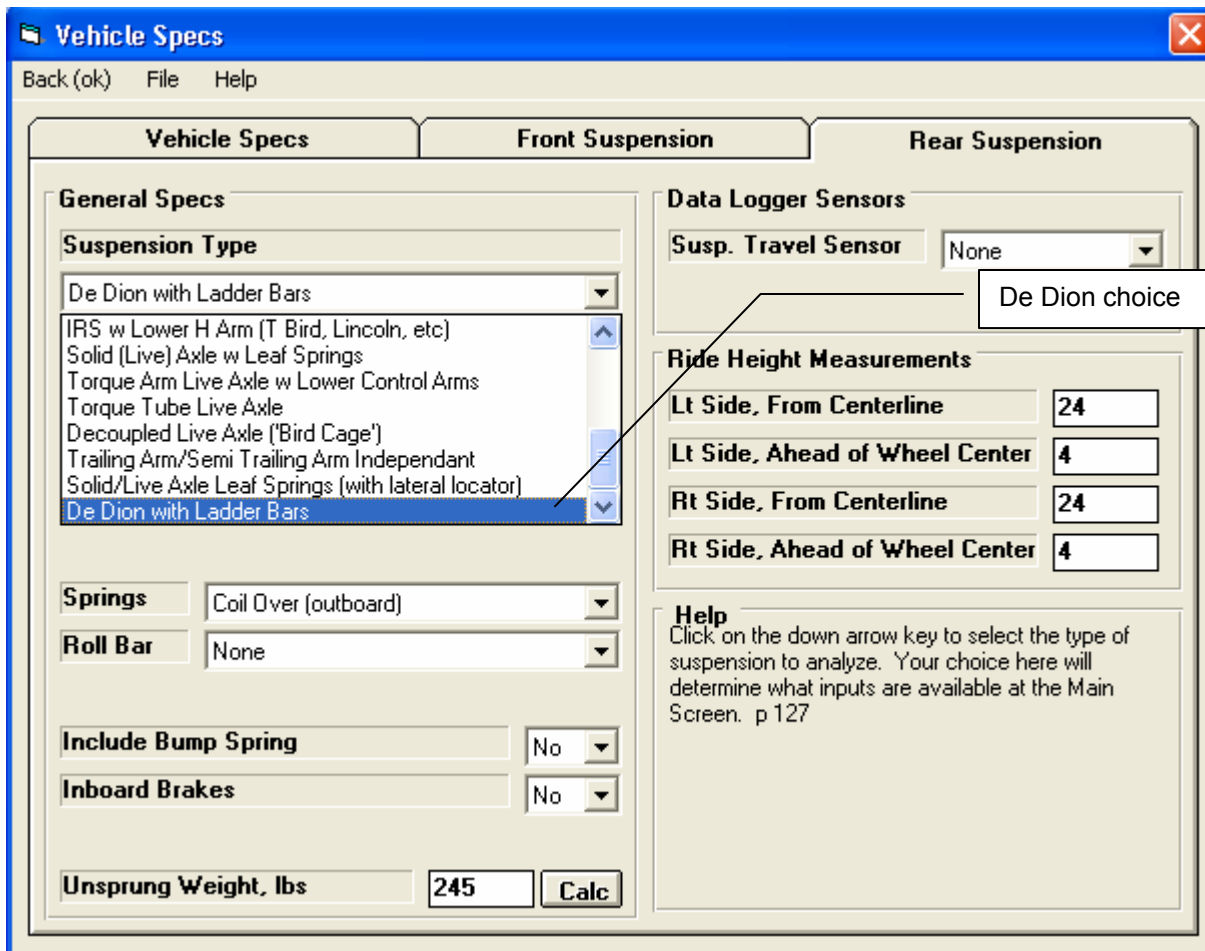
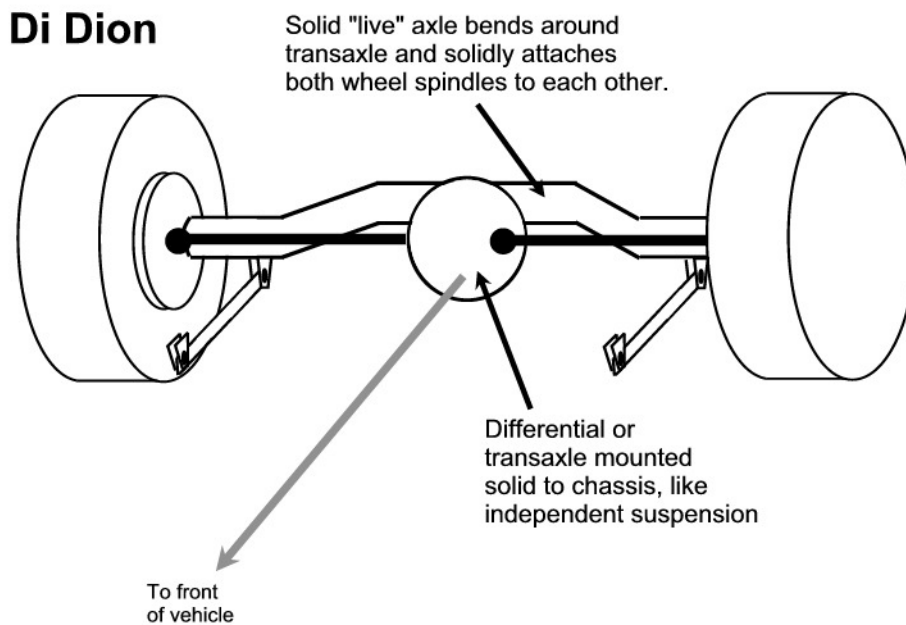
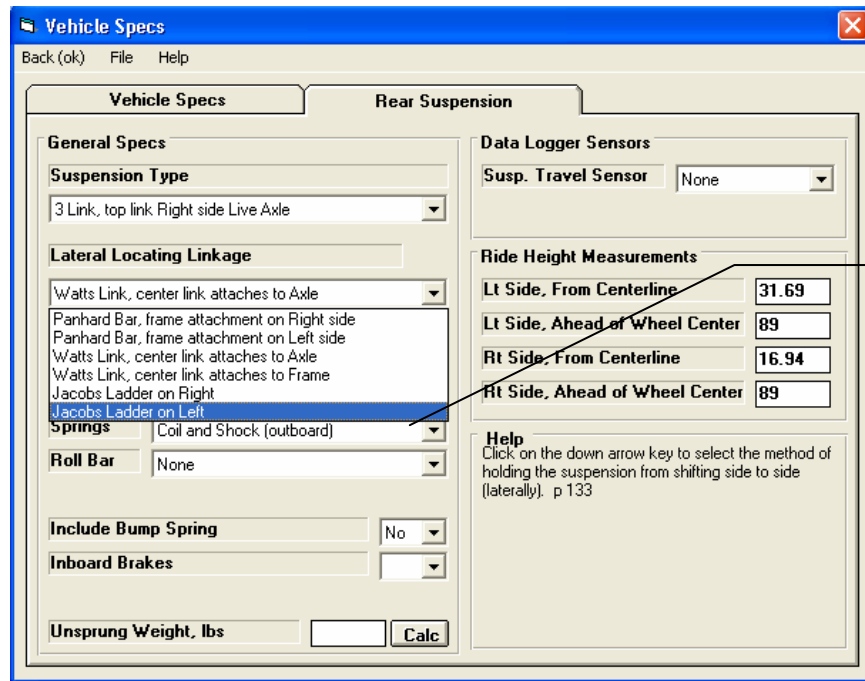
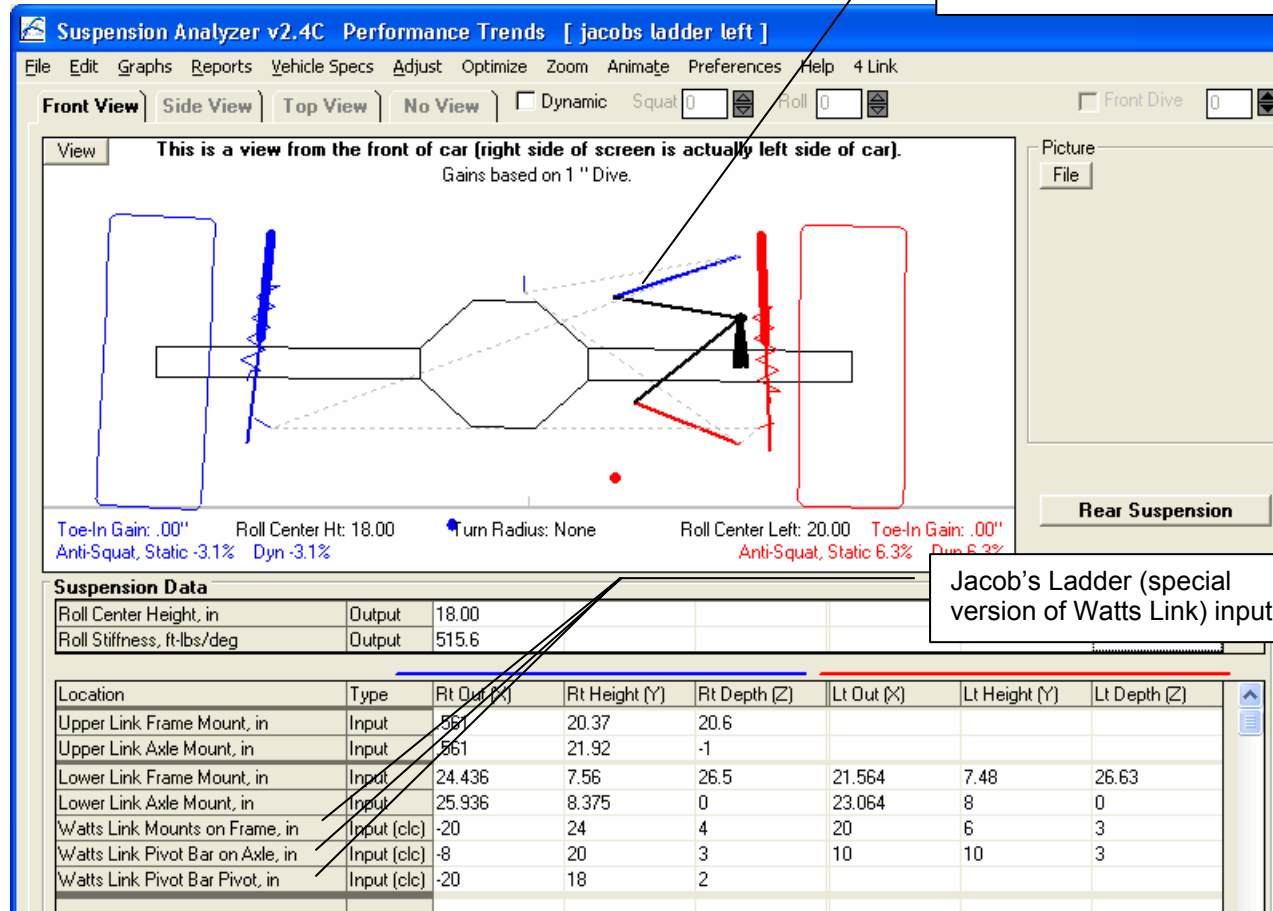


Figure A 6.53 Jacob's Ladder



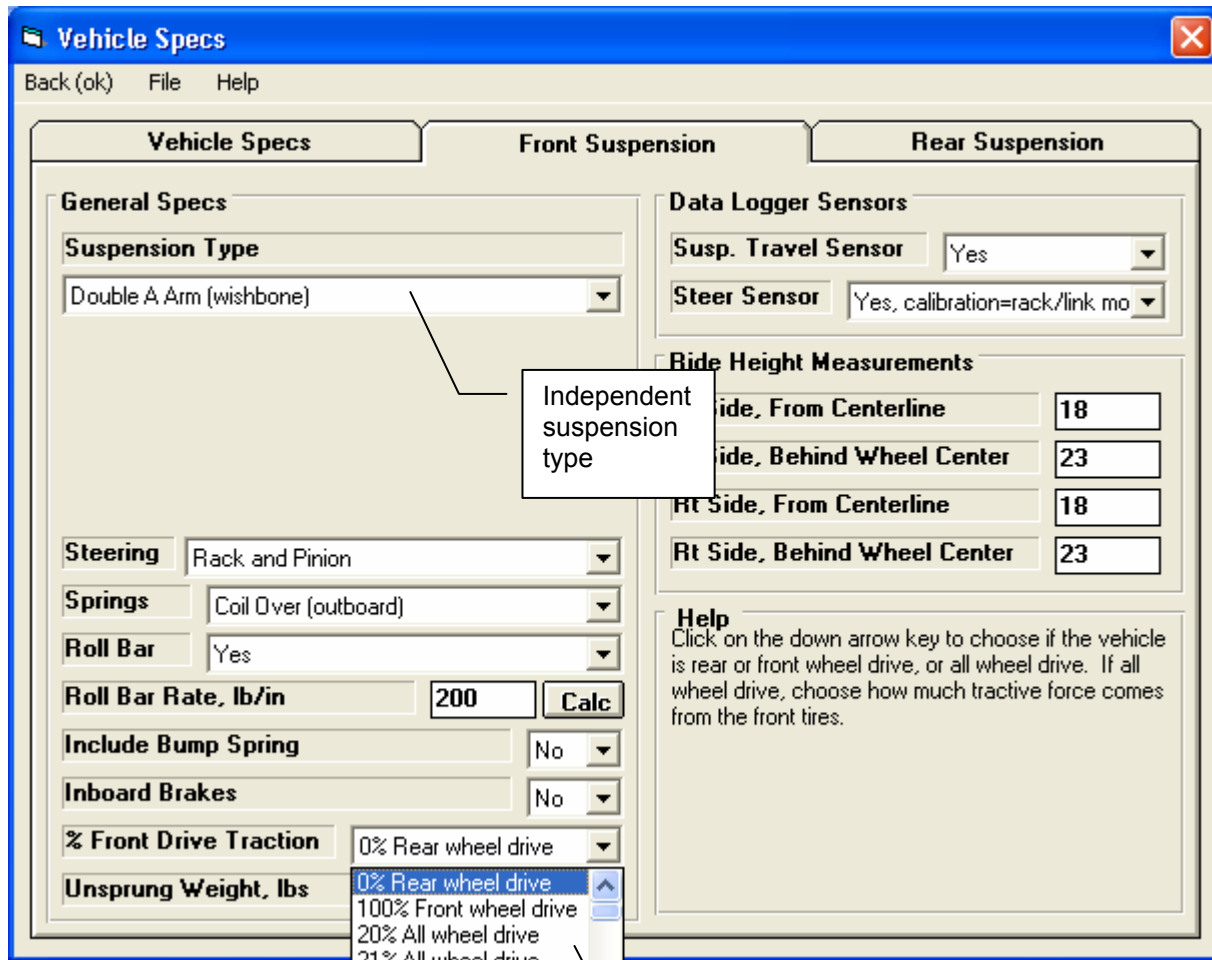
Jacob's Ladder choices

Jacob's Ladder in drawing



Jacob's Ladder (special version of Watts Link) inputs

Figure A 6.54 Independent Suspension Half Shaft Motion



Independent suspension type

Your choice here determines if the traction is coming from the front or rear suspension (front or rear wheel drive). If you pick something other than 0% or 100%, the program assumes all wheel drive, that there are half shafts on both suspensions, if they are independent.

Figure A 6.55 Independent Suspension Half Shaft Motion, cont

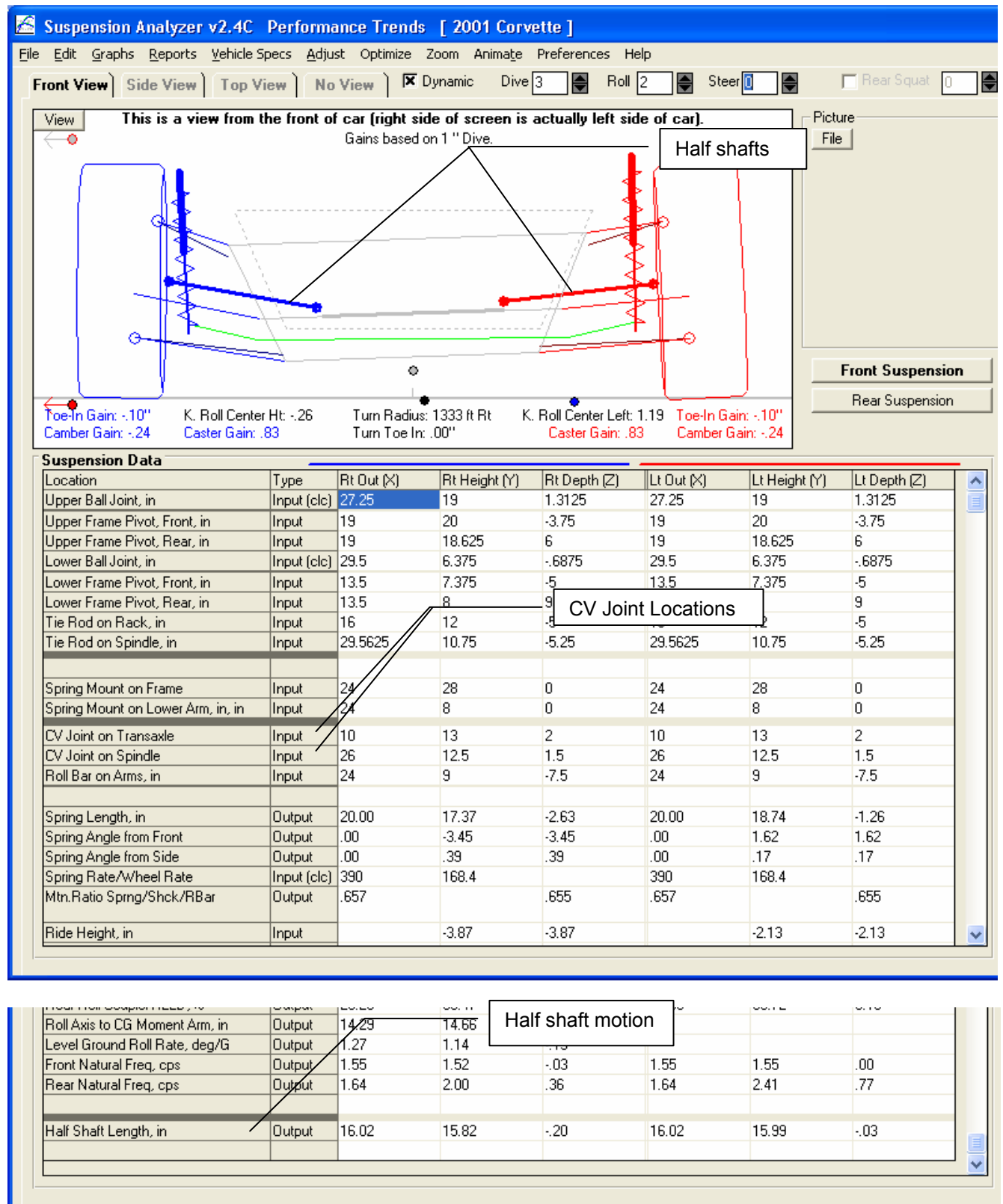
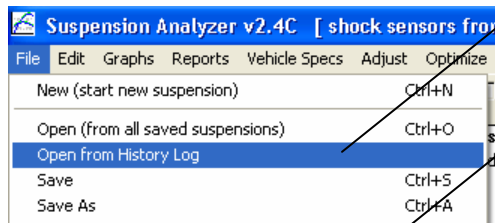


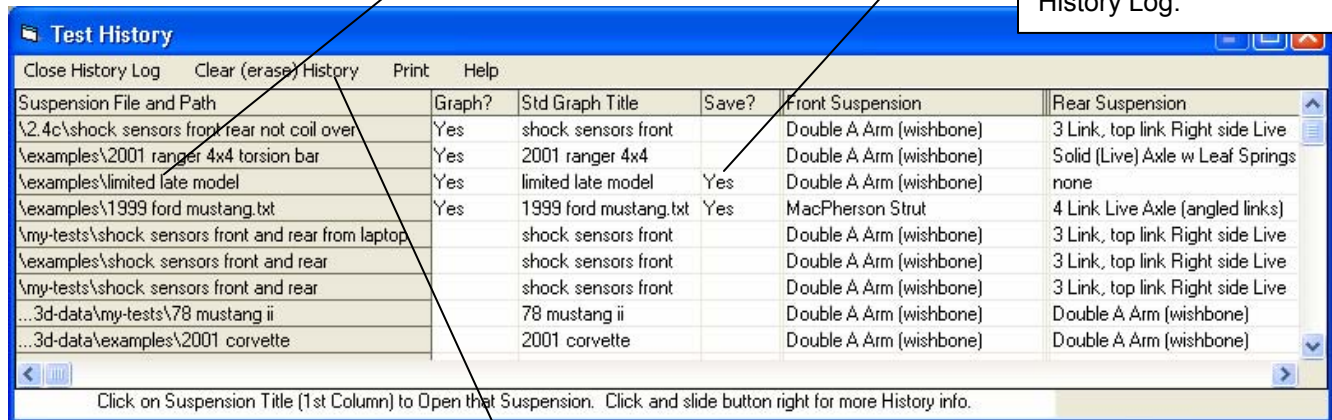
Figure A 6.56 History Log Features



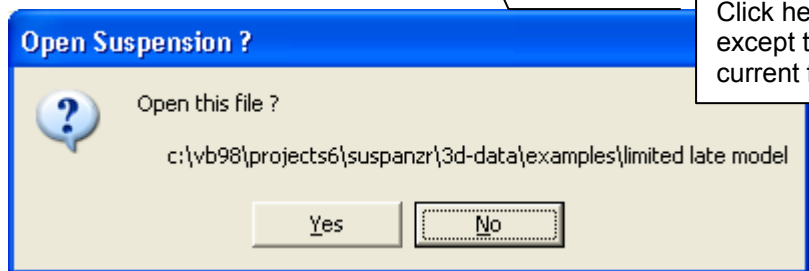
Opening History Log from Main Screen to view recent history and open recently used files.

Click on File Name and Path here to open this file.

Click here to put a Yes in this column to keep this particular file in the History Log.

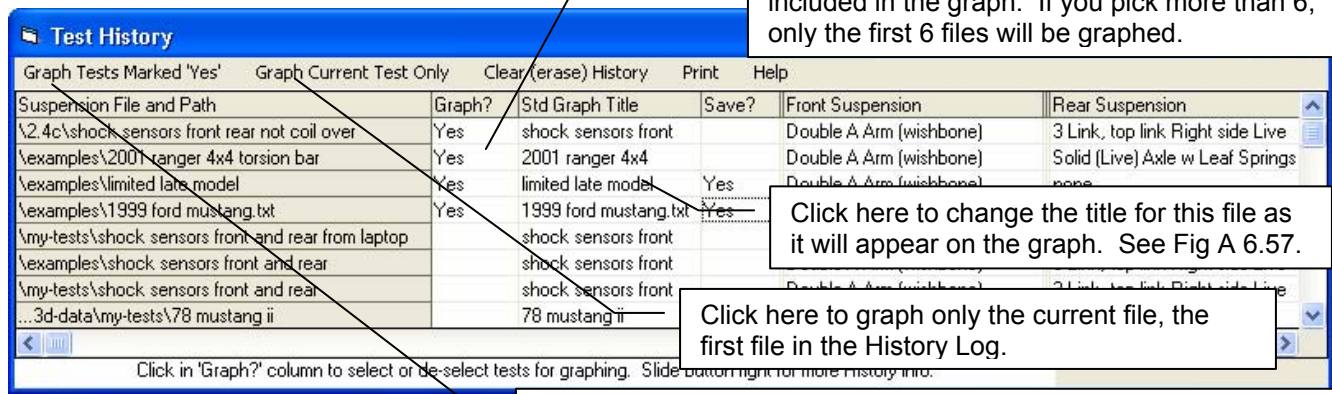
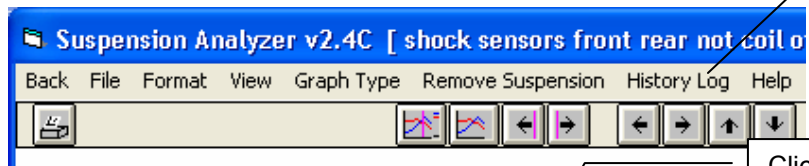


Click on Suspension Title (1st Column) to Open that Suspension. Click and slide button right for more History info.



Click here to erase all files out of the History Log except those marked Yes to "Save?" and the current file in the first row.

In Graph screen, click here to access the History Log.



Click to put a Yes here and this file will be included in the graph. If you pick more than 6, only the first 6 files will be graphed.

Click here to change the title for this file as it will appear on the graph. See Fig A 6.57.

Click here to graph only the current file, the first file in the History Log.

Click here to graph all tests marked Yes, up to 6 test maximum.

Figure A 6.57 History Log Features for Graph Screen

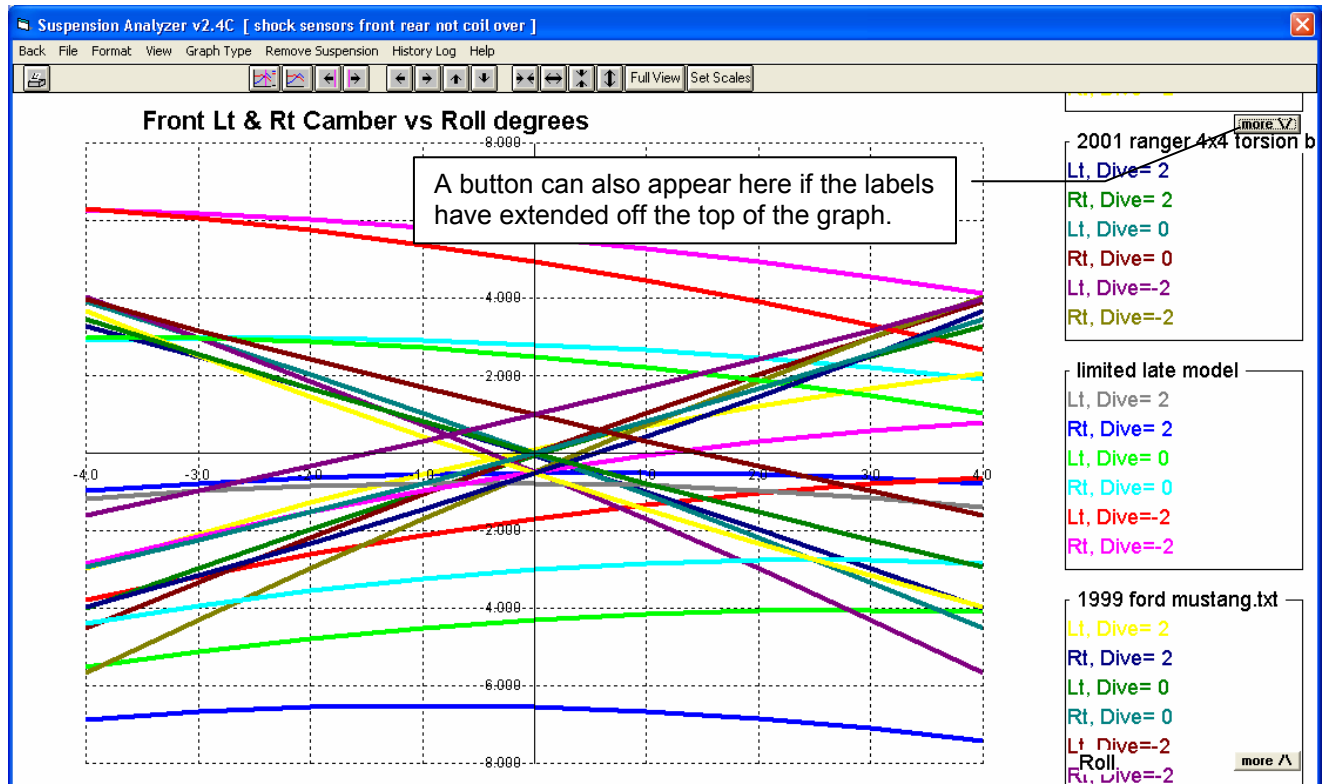
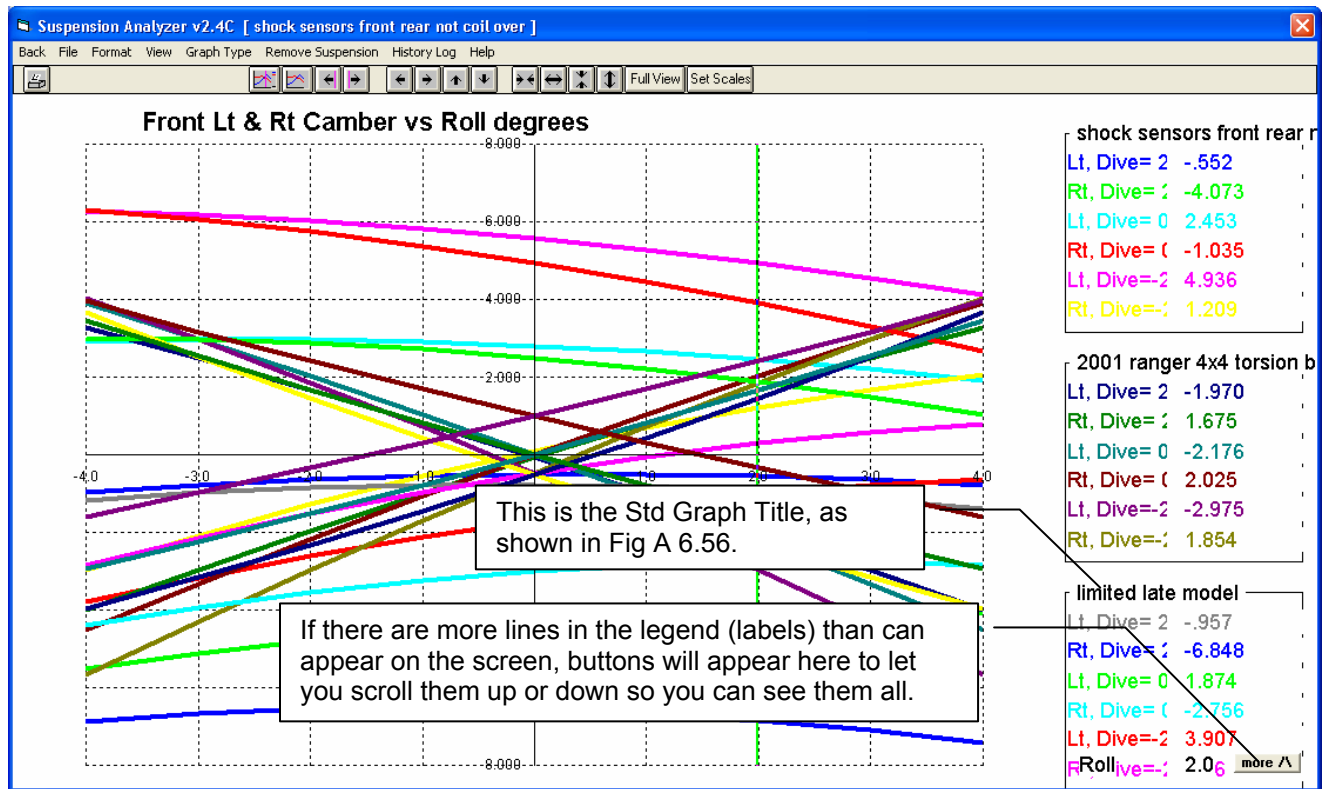
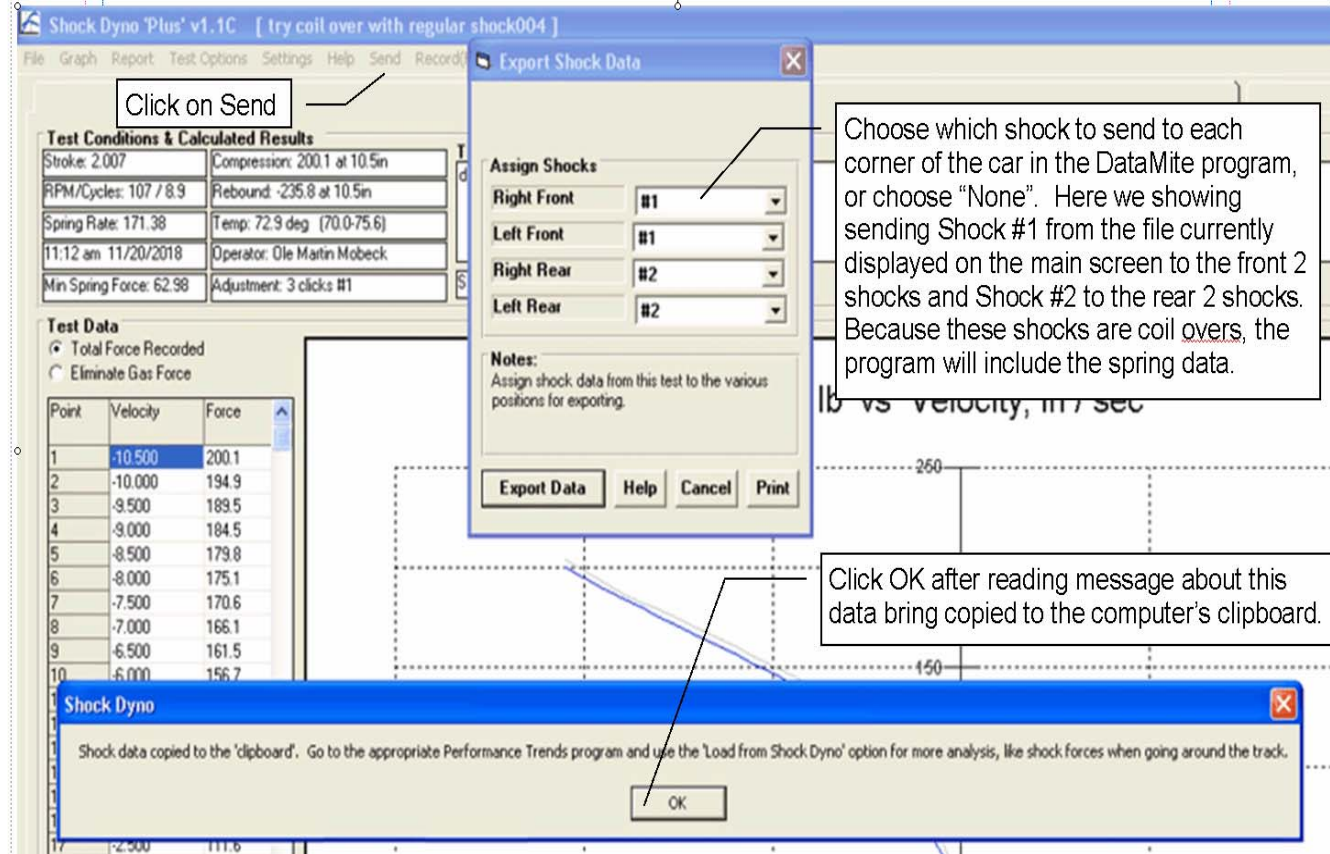


Figure A 6.58 Copying Shock Data from Performance Trends' Shock Dyno Software

If you have an appropriate Shock Dyno Plus version, you can click on the 'Send' option and be presented with the 4 corners of the car. For each corner you can select which shock or coil over's data to send, or choose "None" for that particular corner. You may have to open other Shock Dyno files, do the Send and select different corners of the car for sending shock data for different shocks.



As shown in the picture, the Export Data will copy this data to the computer's clipboard. This is the same process as doing a Windows Ctrl-C or a Copy process. Therefore, do not do a copy or paste command before you go to your Suspension Analyzer program to import this data.

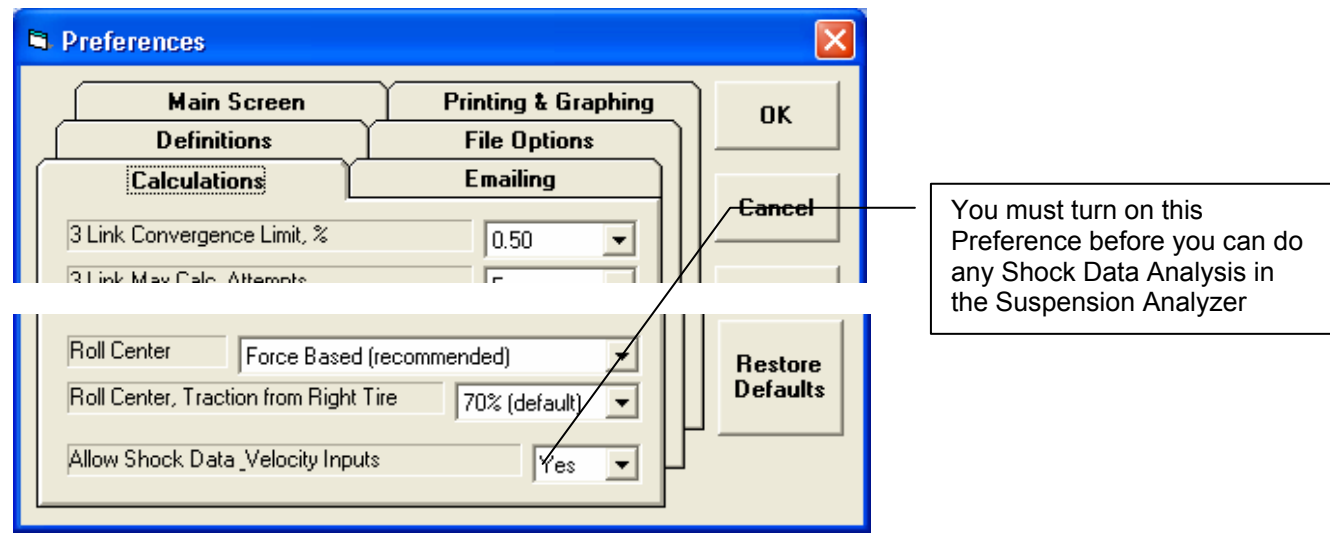


Figure A 6.59 Shock Data Screen

The screenshot shows the 'Shock Specs' dialog box in the Suspension Analyzer software. The dialog has tabs for 'Vehicle Specs', 'Front Suspension', and 'Rear Suspension'. The 'Shock Specs' tab is active, showing radio buttons for 'Right Front', 'Left Front', 'Right Rear', and 'Left Rear'. A 'Labels/Comments' section contains a 'Comment' field with the text 'From Shock Dyno: #1 - Dixon Oh Ins/v6 2007' and a 'Shock Adjustment' field with '4 clicks'. Below this is a 'Shock Dyno Graph' showing a blue curve on a grid. At the bottom, there are two tables of data: 'Velocity Force' and 'Velocity Force'. A 'Help' section contains the text 'Enter a comment to describe this shock or spring'. At the very bottom of the dialog are 'Clear', 'Print', and 'Sort' buttons.

Click Vehicle Specs

Click Shock Data

Edit options let you copy data from one Shock Absorber position to a different one.

Click here for showing data for different shocks.

General information, which may be imported from Performance Trends Shock Dyno program or that you may enter for your own information.

Typical graph slopes from upper left down to lower right. That is because negative velocity is the shock compressing, but that produces a positive force.

Manually enter data from a shock dyno graph, or import from Performance Trends Shock Dyno program.

Velocity	Force	Velocity	Force
-4.750	318.2	.000	-34.6
-4.500	306.3	.250	-68.3
-3.500	255.0	.500	-103.4
-2.500	176.9	1.500	-211.7
-1.500	120.0	2.500	-263.6
-.500	18.1	3.500	-301.9
-.250	-11.9	4.750	-402.6

If you enter data out of order, say at -5"/sec, then 2"/sec, then -1"/sec, the graph will look strange. Click this Sort button and the program will rearrange you data starting with lowest velocity first going up to highest velocity.

Figure A 6.60 Importing Shock Data from Performance Trends' Shock Dyno Software

Shock Specs

OK (back) File Load from Shock Dyno Edit Help

Right Front Left Front Right Rear Left Rear

Labels/Comments

Comment From Shock Dyno: #1 - Dixon Ohlins v6 2007

Shock Adjustment

Import Shock Dyno Data

Right Front
Spring Rate: 562.52
Spring Free Length: 2.35
Adjustment:

File Name: #1 - Dixon Ohlins v6 2007 ohlins track shock service

Data Point 1	-4.750	318.2
Data Point 2	-4.500	306.3
Data Point 3	-3.500	255.0
Data Point 4	-2.500	176.9
Data Point 5	-1.500	120.0

Data above was organized, then placed in clipboard by the Shock Dyno program

Import Cancel

-500	18.1	1500	-211.7
-250	-11.9	2500	-263.6
		3500	-301.9
		4750	-402.6

Clear Print Sort

Click here and this new frame will appear with the shock data loaded from the clipboard displayed.

Performance Trends' Shock Dyno

3-D Suspension Analyzer

No shock dyno data found in clip board for importing.

You must have the correct version of Performance Trends Shock Dyno software and click the 'Send' option at the top of the Shock Dyno's main screen to copy data to the computer's clip board.

OK

Figure A 6.61 Spring and Shock Force Data, manual inputs

Suspension Analyzer v2.4C [shock sensors front rear not coil over]
 File Edit Graphs Reports Vehicle Specs Adjust Optimize Zoom Animate Preferences Help

Front View | Side View | Top View | No View | Dynamic Dive 2 Roll 1 Steer 5 Rear Squat 1

View This is a view from the front of car (right side of screen is actually left side of car).
 Gains based on 1" Dive.

Toe-In Gain: .00" F.B. Roll Center Ht: 1.94 Turn Radius: 115 ft Lt F.B. Roll Center Right: .40 Toe-In Gain: .21"
 Camber Gain: -1.20 Caster Gain: .05 Turn Toe In: .00" Caster Gain: .13 Camber Gain: -1.58

Picture
 File
 Front Suspension
 Rear Suspension

Suspension Data

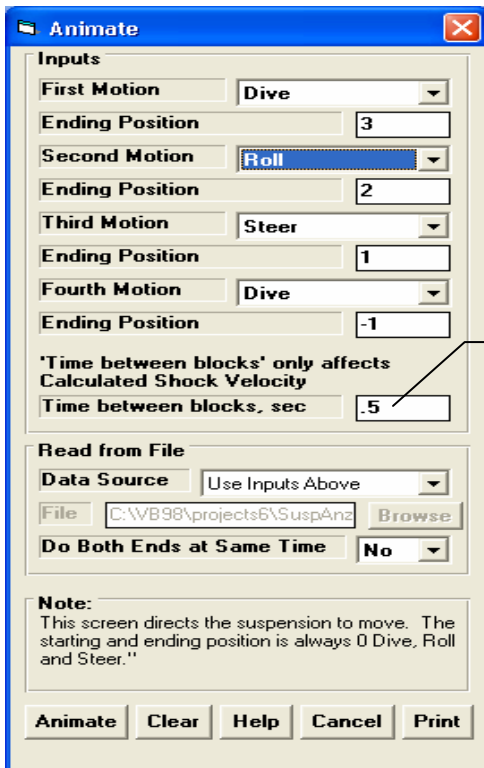
Location	Type	Rt Static	Rt Dynamic	Rt Change	Lt Static	Lt Dynamic	Lt Change
King Pin Angle, deg	Output	13.30	15.72	2.42	12.77	16.08	3.31
Scrub Radius, in	Output	5.29	5.19	-1.10	5.29	5.20	-.09
Spindle Angle, deg	Output	11.60			15.57		
Instant Center Height, in	Output	4.28	1.91	-2.37	5.13	2.55	-2.58
Instant Center Left, in	Output	20.65	3.90	-16.75	5.27	.65	-4.62
F.B. Roll Center Height, in	Output	3.16	1.94	-1.22			
F.B. Roll Center Right	Output	.13	.40	.27			
Roll Stiffness, ft-lbs/deg	Output	1076.2	1285.2	209.0			
Anti Dive, %	Output	-.7	1.6	2.3	7.7	12.1	4.4
Jacking Component, in	Output	2.61	1.68	-.93	4.43	2.53	-1.90
Upper Arm Len True/Fmt/Rt, in	Output	8.55	9.78	10.36	8.66	9.80	10.45
Lower Arm Len True/Fmt/Rt, in	Output	17.50	17.50	27.09	15.61	15.61	26.11
Spindle Length, in	Output	11.71			12.95		
Tie Rod/Steering Arm Length, in	Output	16.94	5.46		14.62	4.75	
Front View Swing Arm Length, in	Output	54.0	38.2	-15.8	38.7	34.9	-3.8
Side View Swing Arm Length, in	Output	1506.6	13373.0	11866.4	455.8	520.7	64.9
Total Roll Stiffness, ft-lbs/deg	Output	1518.2	1730.0	211.80	some Oversteer	Neutral	
Front Roll Couple/FLLD, %	Output	70.88	74.29	3.41	49.69	51.47	1.78
Rear Roll Couple/FLLD, %	Output	29.12	25.71	-3.41	50.31	48.53	-1.78
Roll Axis to CG Moment Arm, in	Output	8.99	9.43	.44			
Level Ground Roll Rate, deg/G	Output	0.93	0.85	-.08			
Front Natural Freq, cps	Output	2.07	3.48	1.41	1.83	1.84	.01
Rear Natural Freq, cps	Output	1.66	1.63	-.03	1.72	1.75	.03
Spring Force, lbs	Output	579.9	1219.1	639.2	652.3	977.1	324.8
Bump Spring Force, lbs	Output	.0	578.5	578.5	.0	.0	.0
Sway Bar Force, lbs	Output	.0	161.6	161.6	.0	-161.6	-161.6
Total Spring Force, lbs	Output	579.9	1959.1	1379.2	652.3	815.5	163.2
Shock Velocity, in/sec	Input	2			1		
Shock Force, lbs	Output	148.45	.00		-157.55	.00	

Comments/Notes
 Same File as 'Lefthanc
 2002 Lefthander Perir
 Some measurements a
 Shock sensors are mo
 Has shock data import

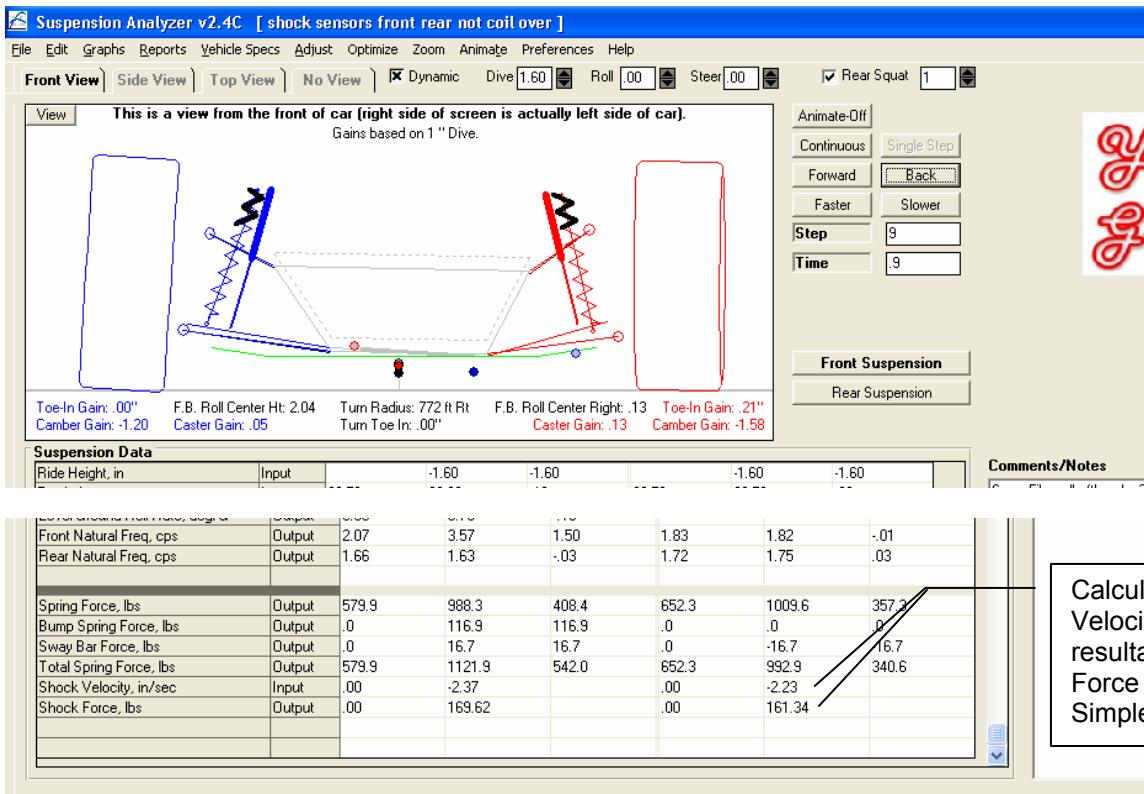
You can manually enter a shock velocity here. A negative velocity means the shock is compressing.

The resultant shock force is displayed here.

Figure A 6.62 Spring and Shock Force Data, Simple Animation

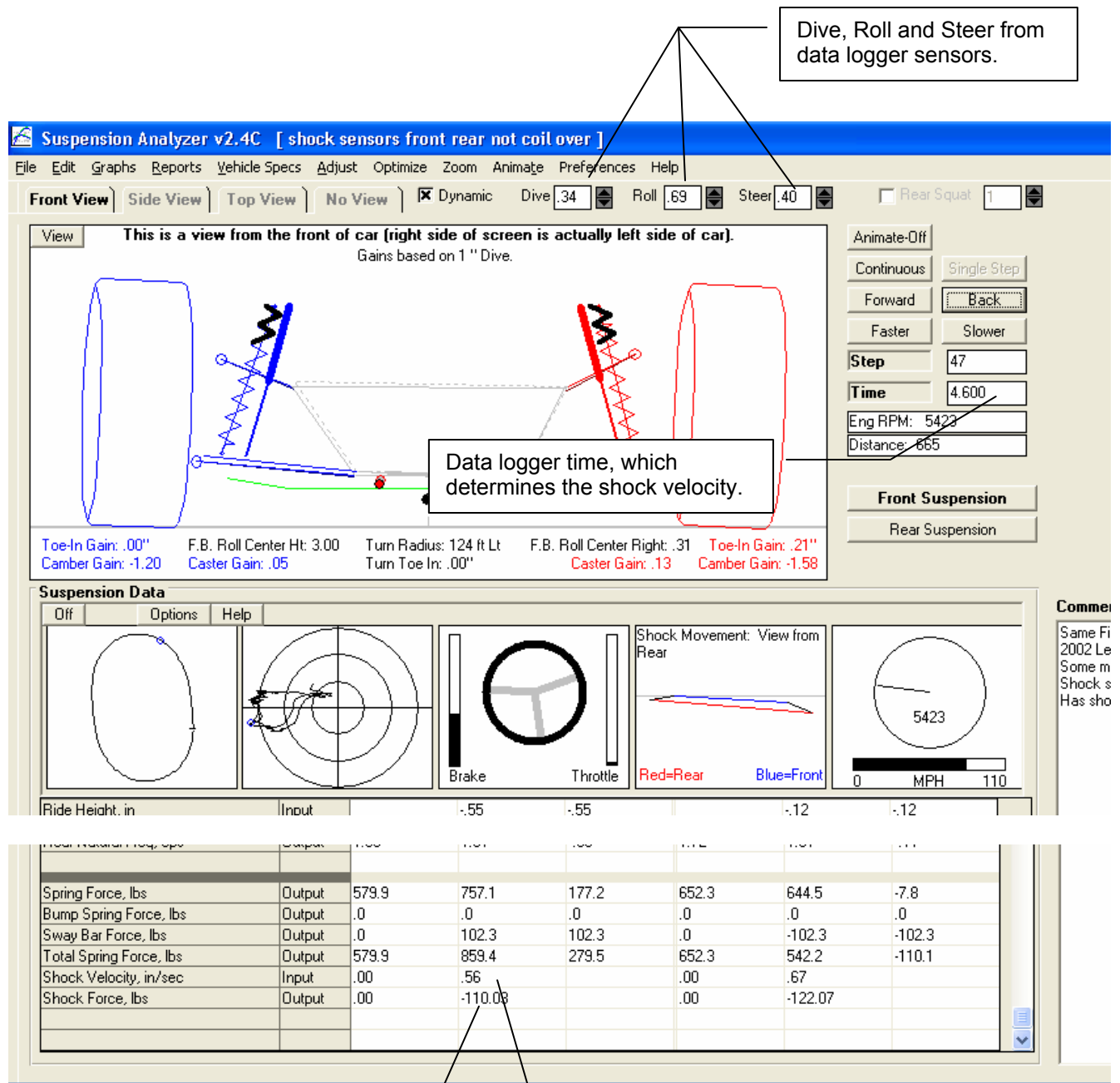


New input in the Animate screen of "Time between blocks, sec". This is used to calculate a Shock Velocity in this Simple Animation mode. For example, the Animation starts at 0 Dive, 0 Roll and 0 Steer. In this screen, the Ending Position for the first block is 3. With a "Time between blocks, sec", of 0.5 seconds, this means the vehicle will dive 3" in 0.0 seconds. This info along with the motion ratio of the shock will determine the resulting shock velocity.



Calculated Shock Velocity and the resultant Shock Force for this Simple Animation.

Figure A 6.63 Spring and Shock Force Data, Animation from Data Logger File



Shock Force calculated from the Shock Velocity determined by the program and the corresponding force from the Shock Dyno data tables.

Shock Velocity calculated from the change in shock length data and the time between data points. This velocity is most accurate once the program has displayed all time steps. That way the program knows both the shock length before and after the time step being displayed. Until that time, the program only knows the shock length for the current time step and the last time step, and not the next time step.

Figure A 6.64 Watch Rows to Watch Data of Particular Interest

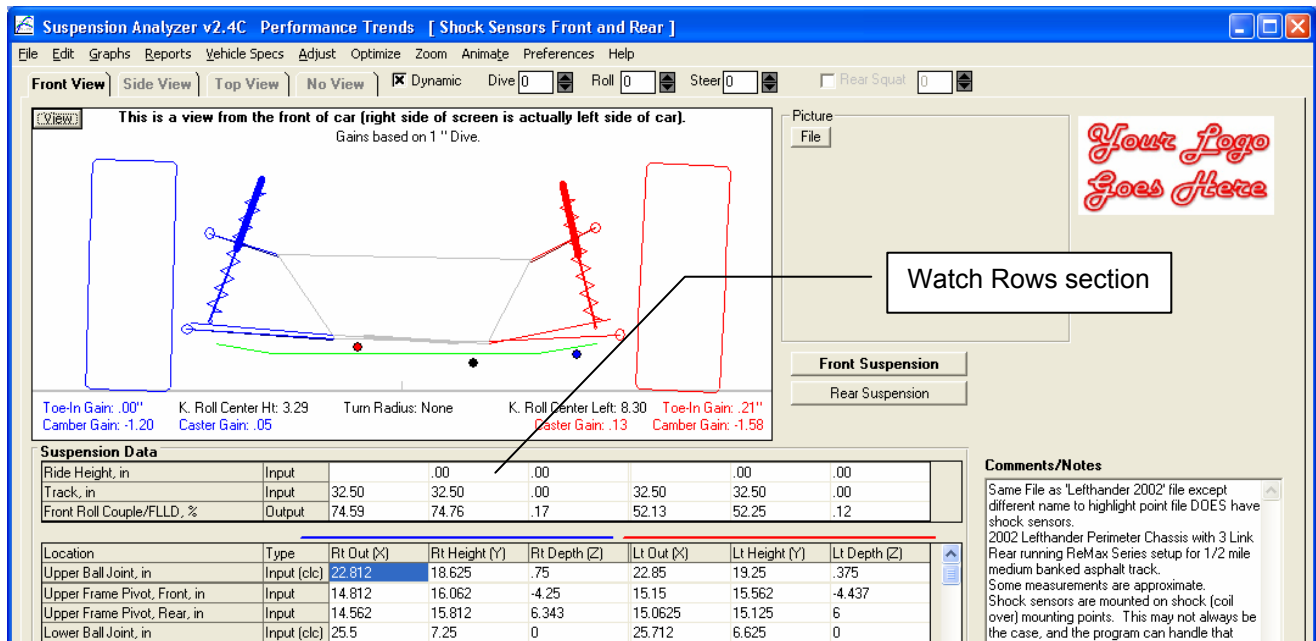
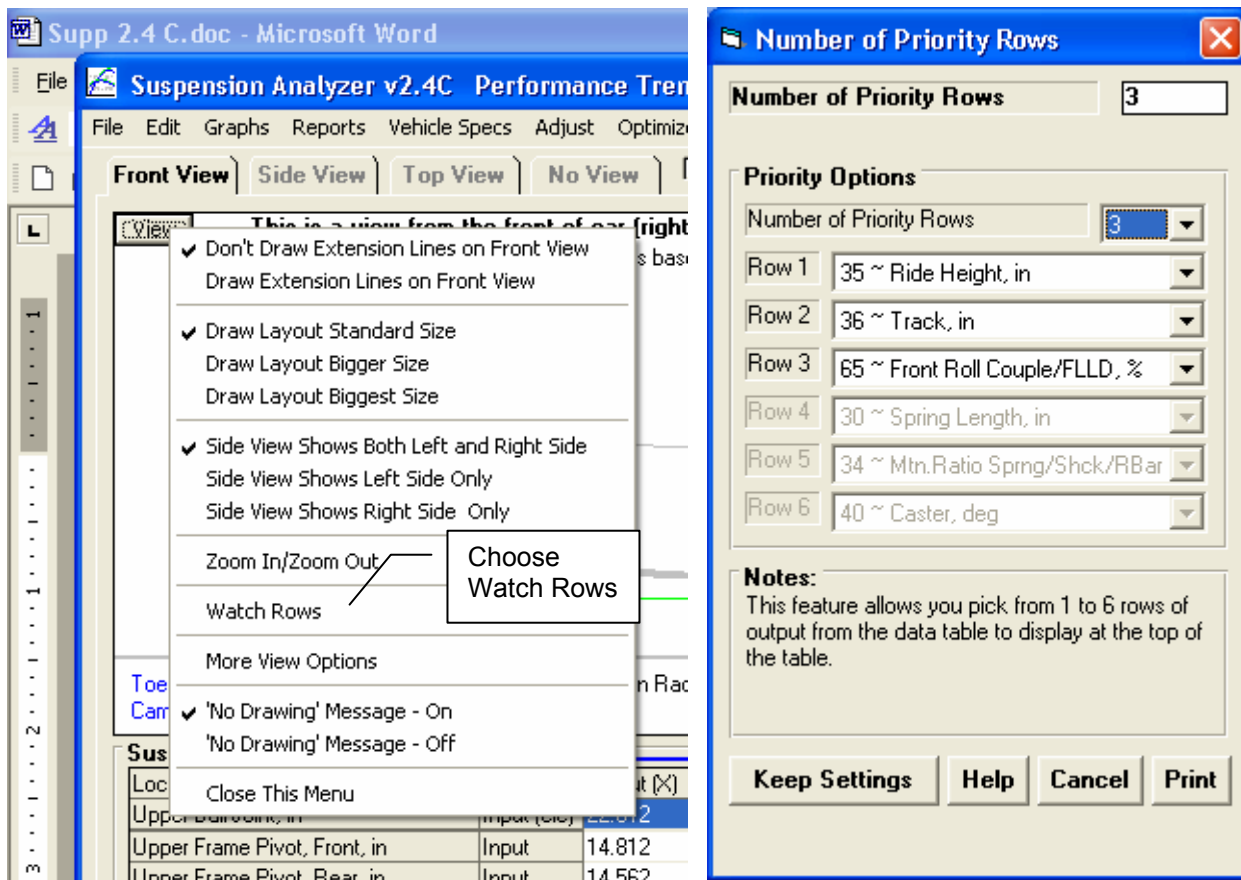


Figure A 6.65 More Detailed and Accurate Anti-Roll Bar Calculation Utility

Calc Roll Bar Rate 10.7

Inputs

- Bar Type: Hollow Bar, 1 Blade End
- Bar Outside: Solid Bar, Straight Ends
- Bar Inside D: Hollow Bar, Straight End
- Active Bar L: Solid Bar, Angled Ends
- Arm Length: Solid Bar, Splined Ends
- Blade Length: Hollow Bar, Splined End
- Blade Thickness: Solid Bar, 1 Blade End
- Blade Width: Hollow Bar, 1 Blade End
- Blade Thickness: .1
- Blade Width: 1.5
- Arm Material: Steel
- Blade Angle: 0

Note:
Active Bar Length is the length of the bar that is designed to twist, which usually has a smaller than the rest of the bar. Arm Length is the distance from the bar mounts on the frame back to where the bar mounts on the suspension. The 'Blade' option assumes the blade is just 1 arm and the arm on the other end has the stiffness of the blade at its stiffest condition, at 90 deg.

Use Calc Value Help Cancel Print

Several new choices which account for flex in the arms, and the new "blade" option which has adjustable flex.

Drawing helps explain inputs.

Calc Roll Bar Rate 491

Inputs

- Bar Type: Hollow Bar, Splined End
- Bar Outside Diameter, in: 1.5
- Bar Inside Diameter, in: 1.3
- Active Bar Length, in: 22
- Arm Length, in: 12
- Arm Length on Angle, in: 15
- Average Arm Height, in: 1.3
- Average Arm Width, in: .6
- Arm Material: Steel

Note:
Active Bar Length is the length of the bar that is designed to twist, which usually has a smaller than the rest of the bar. Arm Length is the distance from the bar mounts on the frame back to where the bar mounts on the suspension.

Use Calc Value Help Cancel Print

Figure A 6.66 Blade Anti-Roll Bar

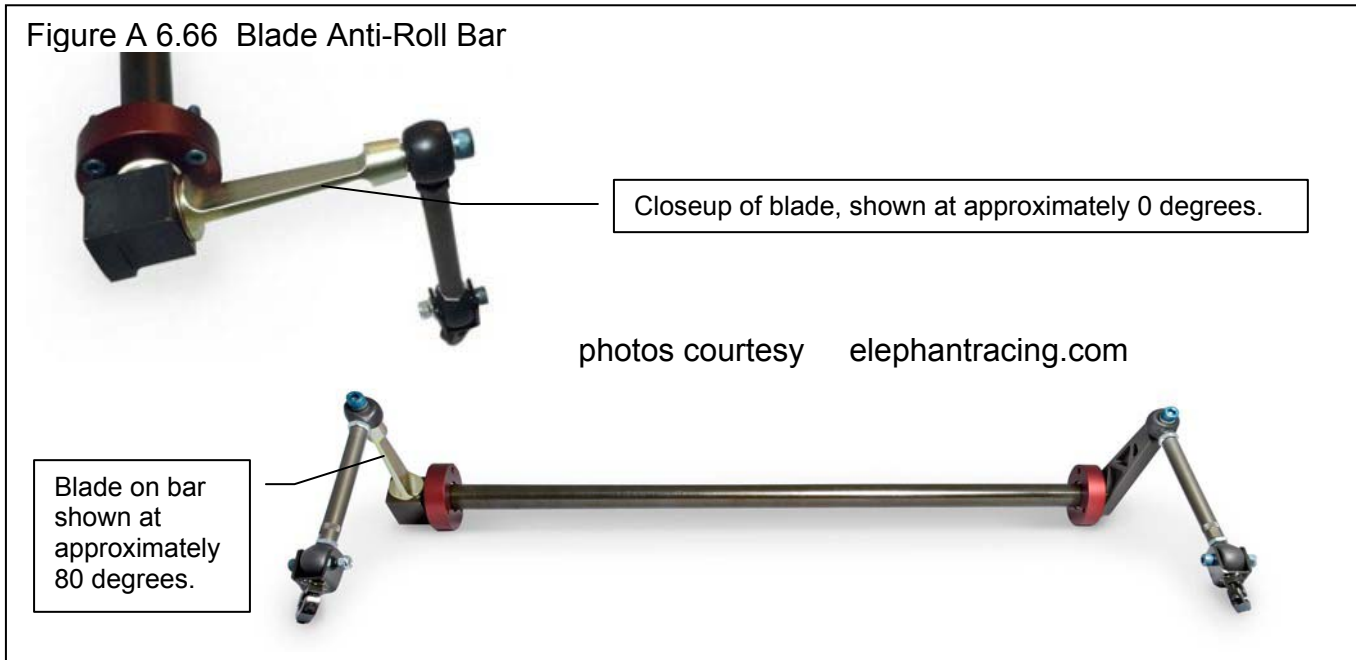


Figure A 6.67 List Files by Access Date

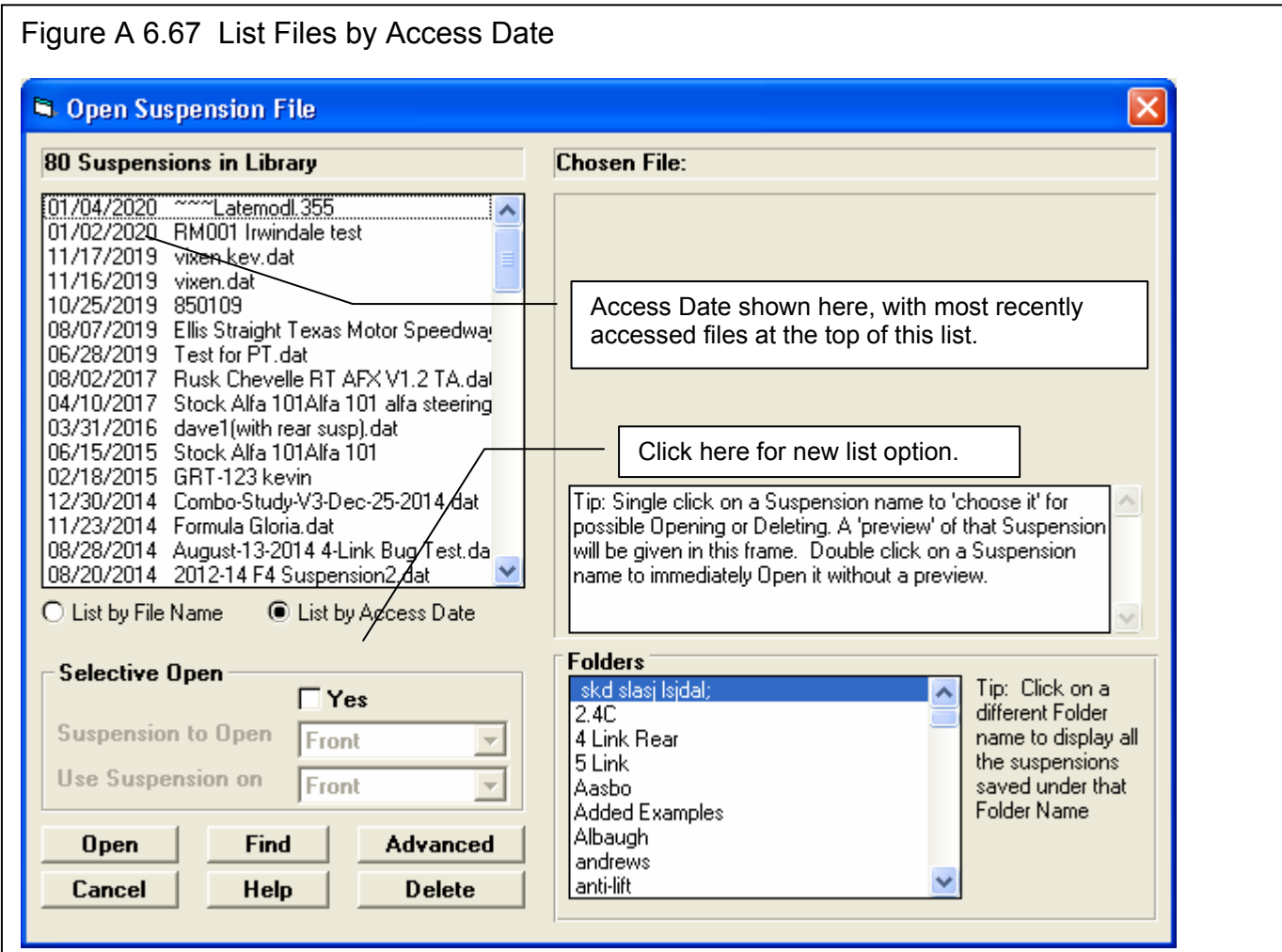


Figure A 6.68 Ball Joint Angle Movement

This is the Current Spindle Angle, which may not match the Spindle Angle used for the Calculation. These may not match if you have changed ball joint locations on the main screen since you last used this screen. In most cases you will change the Spindle Angle used for the Calculation to match Current Spindle Angle.

car (right side of screen is actually left side of car).
Gains based on 1" Dive.

Upper Calc Ball Joint Angle, deg

Calc Left B.J. Angle, deg: 4.3
Calc Right B.J. Angle, deg: 7.3

Left Measurements

Current Spindle Angle, deg: 5.71
Spindle Angle for Calc., deg: 5.71
Ride Height B.J. Flange Angle, deg: 10
Max B.J. Angle Change, deg: 25

Right Measurements

Current Spindle Angle, deg: 5.71
Spindle Angle for Calc., deg: 5.71
Ride Height B.J. Flange Angle, deg: 13
Max B.J. Angle Change, deg: 25

Note:
See diagram and procedure in Section 2.7.4 in manual, page 76.

Use Calc Values Help Cancel Print

Click image for more info on finding the Ball Joint angles

Enter the Max Ball Joint Angle

Click here or here for help shown on next screen.

Click here to load the "Calc Left/Right B.J. Angle, deg" numbers at the top back onto the main screen's table.

Ball Joint Angles show up at the bottom of the table. You can enter the Ride Height Ball Joint Angles directly, shown here as 7.3 and 4.3 degrees on the Upper, 15.7 and 5.7 on the Lower. Or you can click on the "Input (clc)" field to open up the Calculation Utility shown above. In this screen, the ball joint picture is updated as you change angles to show you how your inputs are affecting the "Calc Left/Right B.J. Angle, deg" numbers at the top.

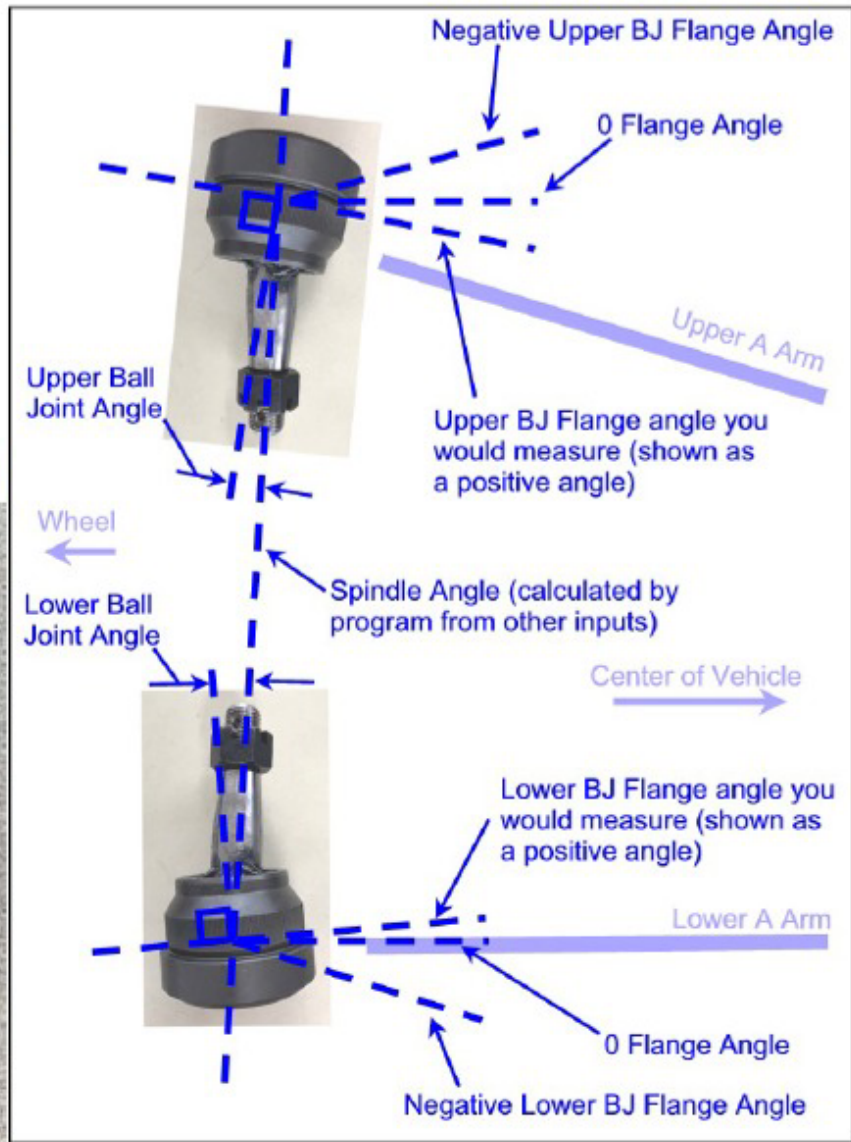
Location	Type	Rt Static
Total Roll Stiffness, ft-lbs/deg	Output	5848.2
	Output	92.10
	Output	7.90
	Output	20.29
Level Ground Roll Rate, deg/G	Output	0.87
Front Natural Freq, cps	Output	2.45
Rear Natural Freq, cps	Output	1.48
Spring Force, lbs	Output	875.7
Bump Spring Force, lbs	Output	.0
Sway Bar Force, lbs	Output	.0
Total Spring Force, lbs	Output	875.7
Shock Velocity, in/sec	Input	
Shock Force, lbs	Output	.00
Upper Ball Joint Angle, deg	Input (clc)	7.3
Lower Ball Joint Angle, deg	Input (clc)	15.7

Figure A 6.69 Ball Joint Angle Movement Help Screen

Ball Joint Angle

The Ball Joint Angle is the angle between the stud angle when it is perfectly vertical (perfectly centered in the ball joint) and the actual angle at ride height, or as the suspension moves. If this angle moves too much, it will reach the end of its possible movement and cause bind and damage.

This input screen lets you simply measure the angle of the ball joint



"flange", or anything that is horizontal on the ball joint. This can be measured with an inclinometer (angle finder) and entered into this utility screen. The program knows the spindle angle from the ball joint positions you have entered on the main screen.

We tried to make it so most flange angles you would measure would be positive. **Upper** ball joint angles which **angle down** toward the center of the vehicle are called **positive angles**. **Lower** ball joint angles which **angle up** toward the center of the vehicle are called **positive angles**. If the flange was perfectly level, this would be a 0 flange angle. Note that the flange angle is not necessarily the same as the angle of the A Arm.

The Max Ball Joint Angle is measured by moving the ball joint stud to its max tilted position and measuring that angle from when the stud was perfectly vertical. In the picture above marked "Max Ball Joint Angle", this angle is about 30 degrees.

Figure A 6.70 Ball Joint Angle Movement Results

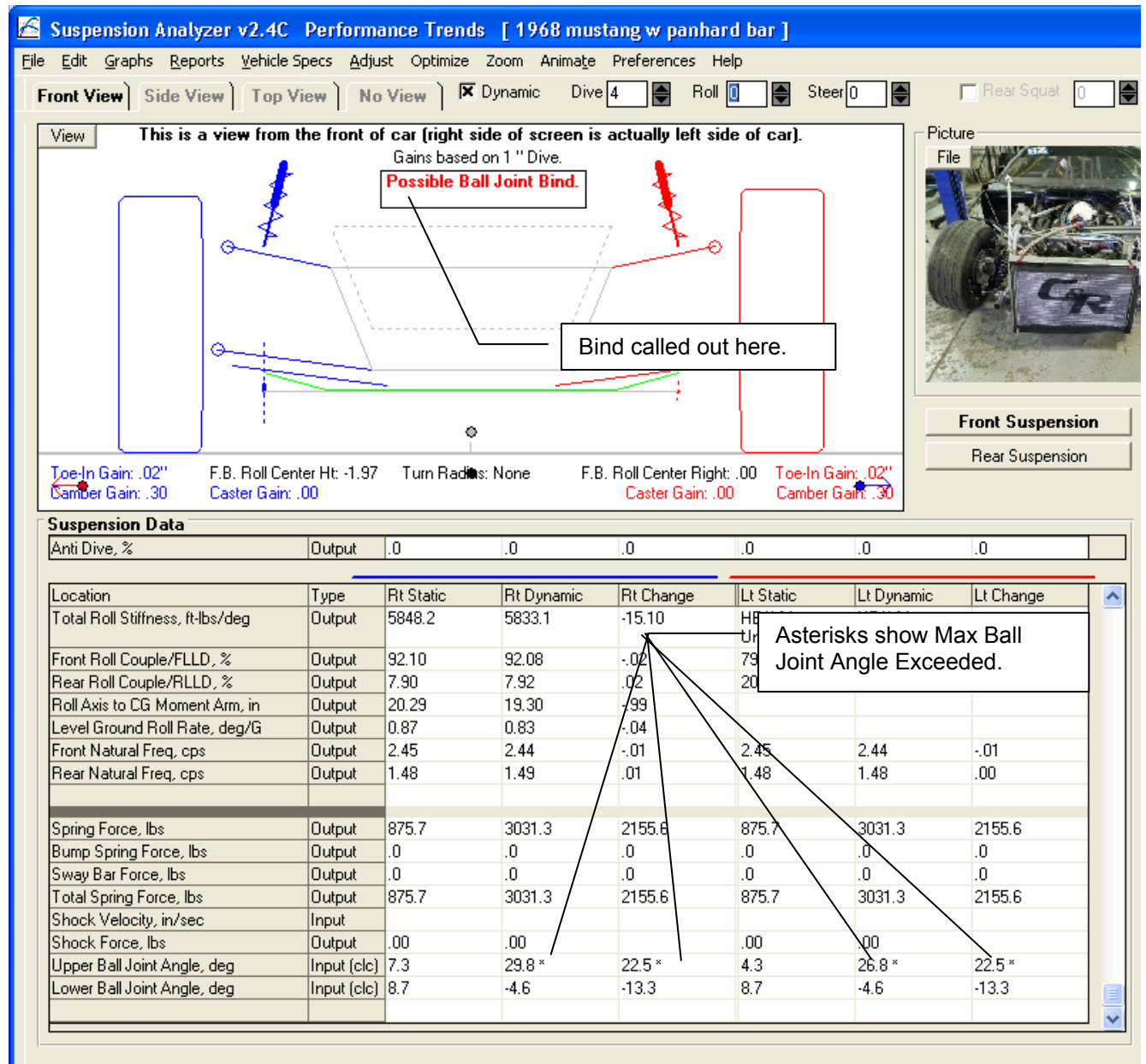
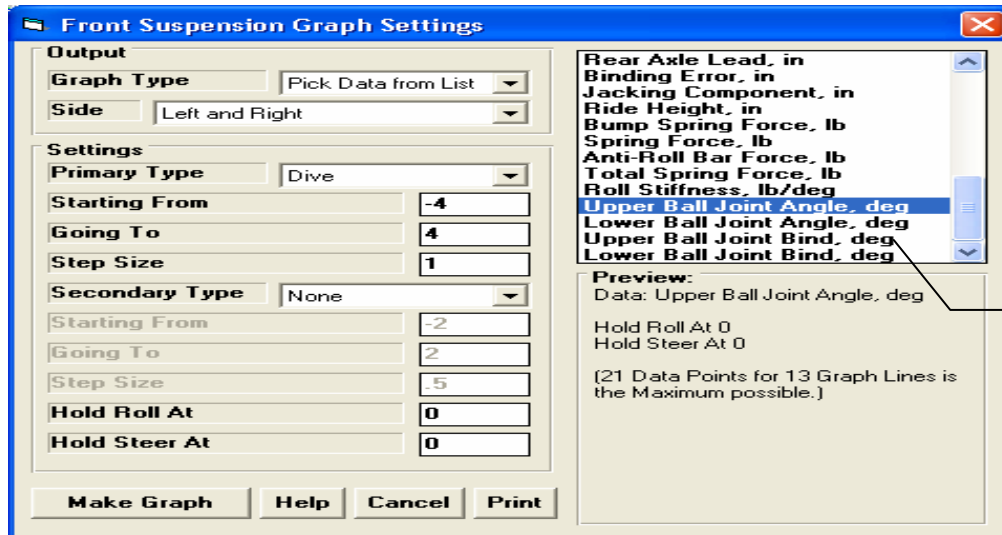
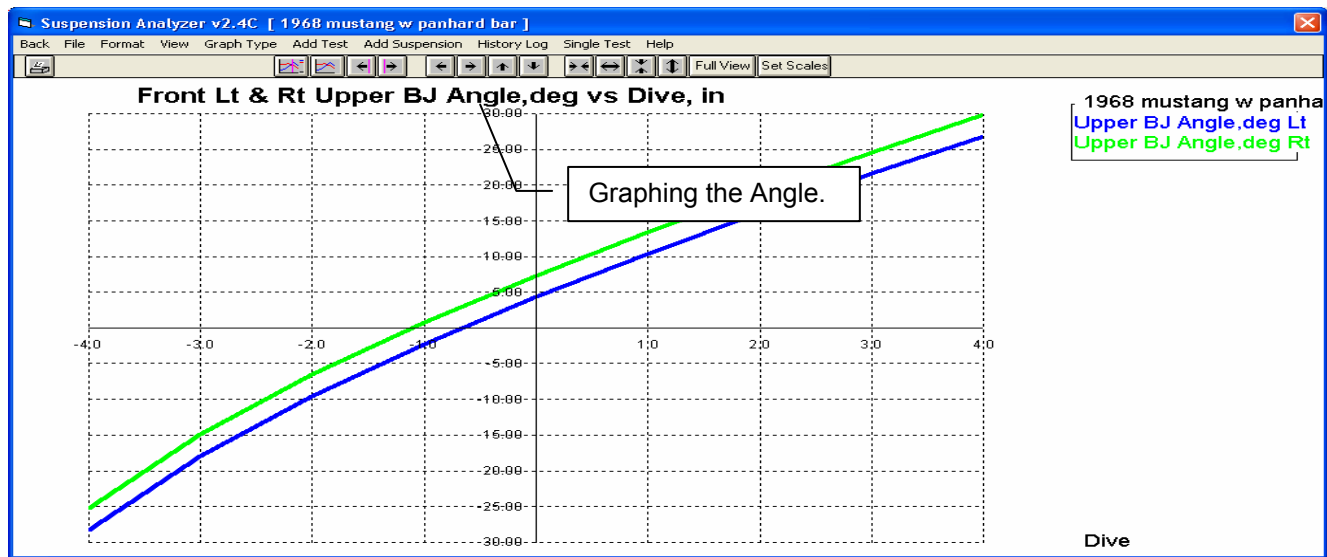


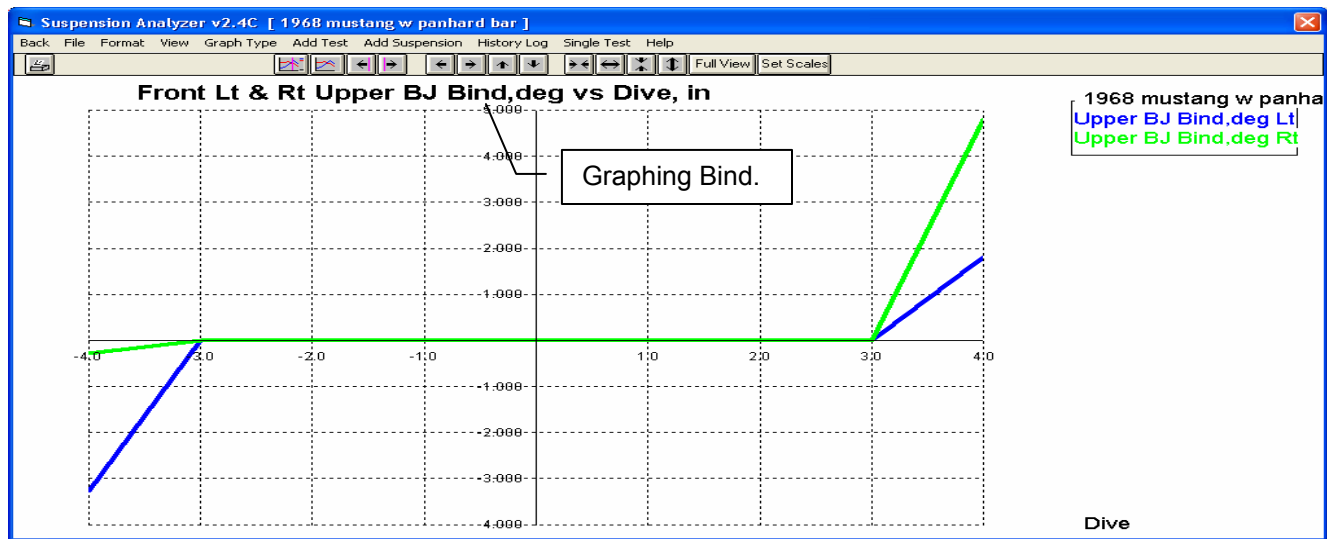
Figure A 6.71 Ball Joint Angle Movement Graph



Second graph was done by selecting this "Bind" option.



1968 mustang w panha
Upper BJ Angle,deg Lt
Upper BJ Angle,deg Rt



1968 mustang w panha
Upper BJ Bind,deg Lt
Upper BJ Bind,deg Rt