

Appendix X New Features in v2.4

Added several new types of Rear Suspensions (Fig A 6.14A), including:

- Torque Tube Live Axle Fig A 6.14
- Torque Arm Live Axle Fig A 6.15
- Trailing Arm and Semi Trailing Arm Independent Fig A 6.16
- 5 Link Independent Fig A 6.17
- 'Decoupled' Live Axle (bird cage) Fig A 6.18

Added 'Four Link' features. These features lets you enter all holes for all 4 link brackets and see all possible combinations, and how each combination will affect anti-squat and roll steer. If you are working with a 4 Link type of rear suspension, and are displaying it in 'Side View', and new menu option of '4 Link' will appear for you to click on. Also, for each 4 link mounting hole, the type of input is specified as 'Input (clc)', where the '(clc)' means if you right click on it, it will ask which side (left or right) bracket you want to specify for entering in several possible mounting holes. Fig A 6.19

Added 'Virtual Scales' features, but clicking on the 'Adjust' drop down menu. Fig A 6.20 This feature has 3 different methods of adjusting corner weights:

- Turning 'Jacking Screws', which changes the preload on the suspension springs on the 4 corners of the vehicle and typically affects Cross Weight only.
- Changing Tire Size, which changes the preload on the suspension springs on the 4 corners of the vehicle and typically affects Cross Weight only.
- Changing Ballast, by adding weight to or removing weight from a certain location of the car, or by moving weight from it's current location to some new location.

Note, 'Virtual Scales' is only available if you are working with both a front and rear suspension on a vehicle.

Refined the method of entering data into the measurements 'Grid'. Now it is not so critical to press <Enter> after each new input.

Program is now more Vista and Windows 7 compatible, and better able to handle latest versions of Adobe Acrobat.

Fixed some Watts Link bugs and now you can have the Watts link pivot mounted on either the axle or the frame of the car. The Watts Link Wizard calculation screen is now easier to get to and suggested by the program to fix Watts Link math errors. Fig A 6.21

Added 3rd option for rear suspension springs, to be able to put spring on the upper arm. For the 'Decoupled' Live Axle (bird cage suspension type, you can also specify the springs are on the bird cage bracket. Fig A 6.22

Program now highlights the appropriate cell in the spreadsheet when you click on a point in the layout drawing. Fig A 6.23

Added a 'View' button on layout drawing so you can quickly change some Preference settings which affect the layout drawing. Fig A 6.24. Some of the new Preferences we've added which can be changed at the View button include:

- Added 'Bigger' Preference so you can select to make the layout drawing bigger on higher resolution screens.
- Added Preference to allow only 1 side to be drawn in side view (helps avoid confusion).

Now all versions have the Ball Joint Wizard for more accurately calculating the location of the center of rotation of the ball joint. Fig A 6.25

Made several changes to graphing to allow for you to press the arrow keys on the keyboard to move graphs around and to not run into limits where zooming and shifting would run into limits.

Program now automatically checks for old versions 1.1 and 2.0 of Suspension Analyzer on your computer for importing files.

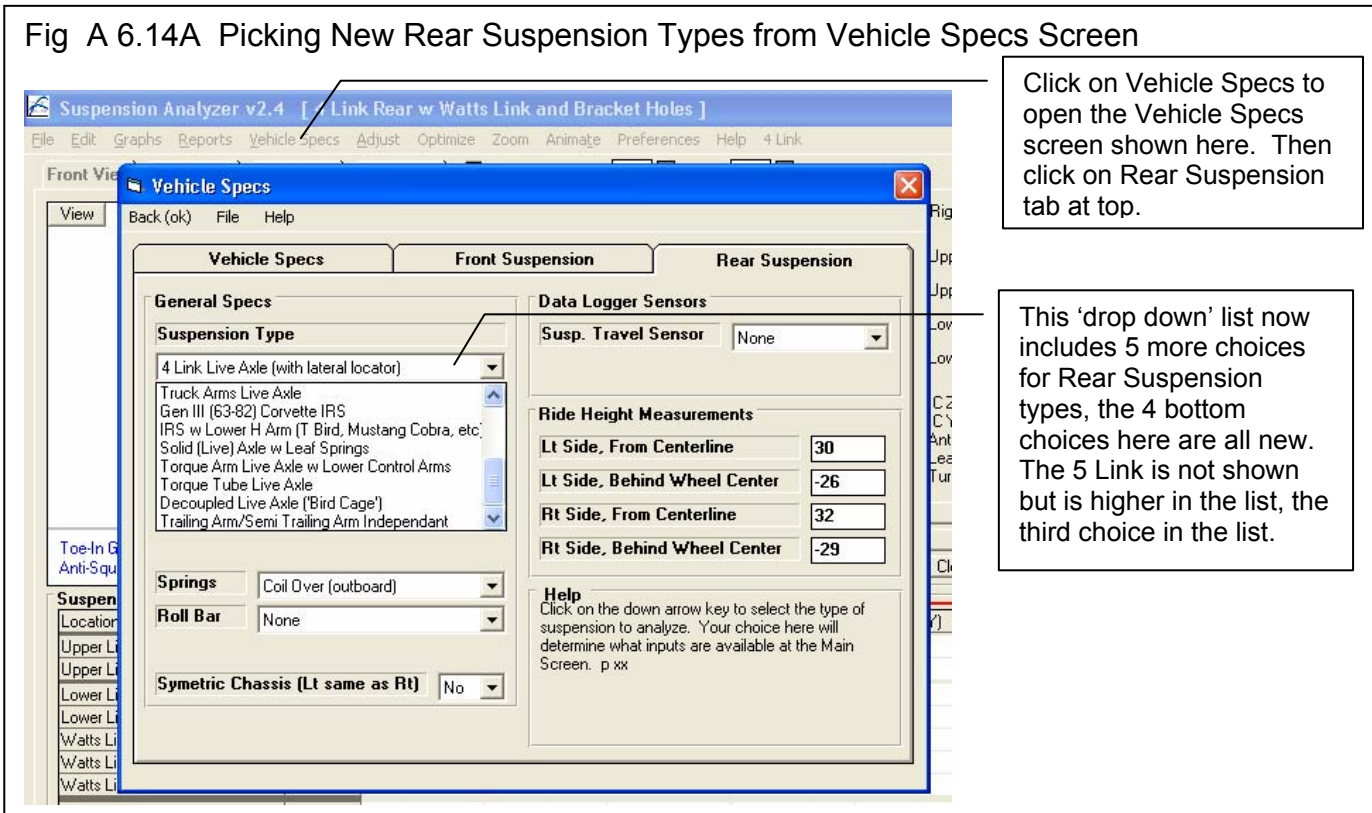
The File, then Import... feature now looks for old versions 1.1 and 2.0 of Suspension Analyzer on your computer for importing files.

When choosing different types of suspensions, the program now better checks for valid types of springs which can be chosen, especially for solid axle rear suspensions. For example, torsion bars, and springs to upper arms can not be used on 3 link.

Added a Preference so user can enter in dimensions as low as -100 inches. This allows for components normally on one side of the car's centerline to actually be mounted on the other side of the car. For example, normally the LEFT lower A arm mount on the frame is mounted to the LEFT of the car's centerline. If you set this preference, you can now mount it, say, -20 inches, so it's actually attached to the frame 20 inches to the RIGHT of the car's centerline.

Added a Preference to be able to display 'Jacking Component at CG' in the results. This shows the vertical jacking component of the force vector at the location 'of the Center of Gravity. As this component increases, there is more jacking 'force on the vehicle from that particular tire. This is very much related 'to Roll Center Height. Fig A 6.26

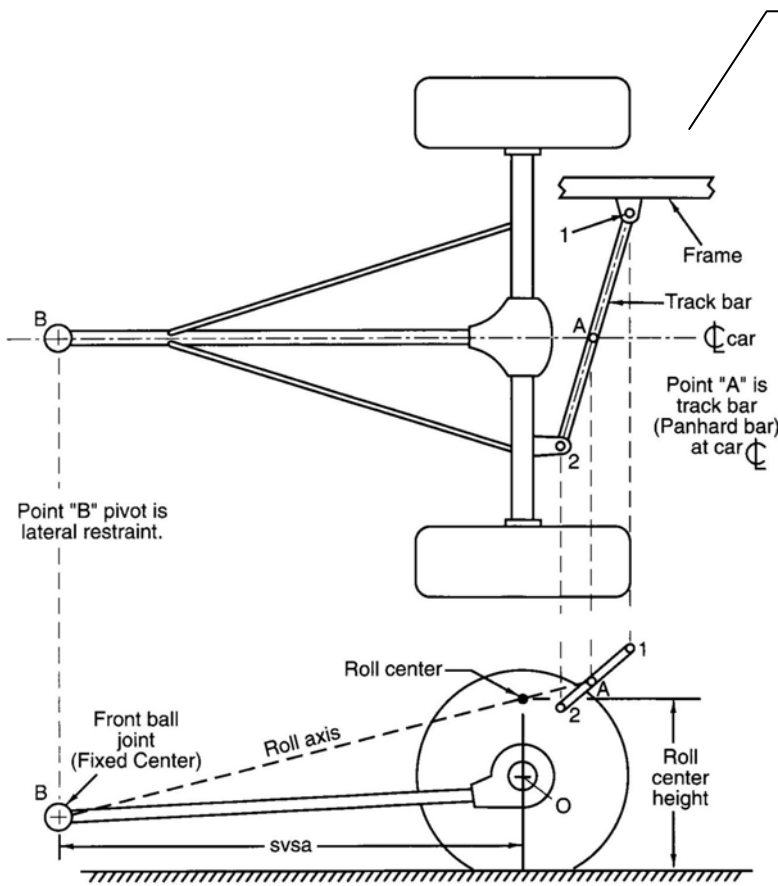
Fig A 6.14A Picking New Rear Suspension Types from Vehicle Specs Screen



Click on Vehicle Specs to open the Vehicle Specs screen shown here. Then click on Rear Suspension tab at top.

This 'drop down' list now includes 5 more choices for Rear Suspension types, the 4 bottom choices here are all new. The 5 Link is not shown but is higher in the list, the third choice in the list.

Fig A 6.14 Torque Tube Live Rear Axle



The Torque Tube rear axle has one "torque tube" link attached at one point, typically up near the transmission. This point is a ball joint allowing motion in most all directions. All accelerating and decelerating torque is transferred through this one point. This tube has supports to resist the axle twisting when viewed from the top (plan view). It then uses some type of lateral locating device (panhard bar shown here) to resist sideways motion.

This suspension was used in the 3rd generation Camaros and Firebirds, 1982-92.

Picture courtesy "Race Car Vehicle Dynamics" by Milliken & Milliken.

Figure 17.39 Torque tube rear axle.

Torque Tube is an example file supplied with program for you to evaluate.

Suspension Analyzer v2.4 Performance Trends [Torque Tube]

File Edit Graphs Reports Vehicle Specs Adjust Optimize Zoom Animate Preferences Help

Front View Side View Top View No View Dynamic Squat 0 Roll 0

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

Toe-In Gain: .00" Roll Center Ht: 12.50 Turn Radius: None Roll Center Right: .00 Toe-In Gain: .00"
 Anti-Squat, Static 168.8% Dyn 168.8% Anti-Squat, Static 168.8% Dyn 168.8%

Rear Suspension

| Suspension Data | | | | | | | |
|--------------------------------|-------------|------------|---------------|--------------|------------|---------------|--------------|
| Location | Type | Rt Out (X) | Rt Height (Y) | Rt Depth (Z) | Lt Out (X) | Lt Height (Y) | Lt Depth (Z) |
| Torque Tube on Frame, in | Input | 1 | 13 | 52 | | | |
| Watts Link Mounts on Frame, in | Input (clc) | 20 | 13 | -8 | 20 | 12 | -8 |
| Spring Mount on Frame | Input | 24 | 29 | -5.5 | 24 | 29 | -5.5 |

Side view of Torque Tube suspension.

Program only needs location of the single ball joint.

Fig A 6.15 Torque Arm Live Rear Axle

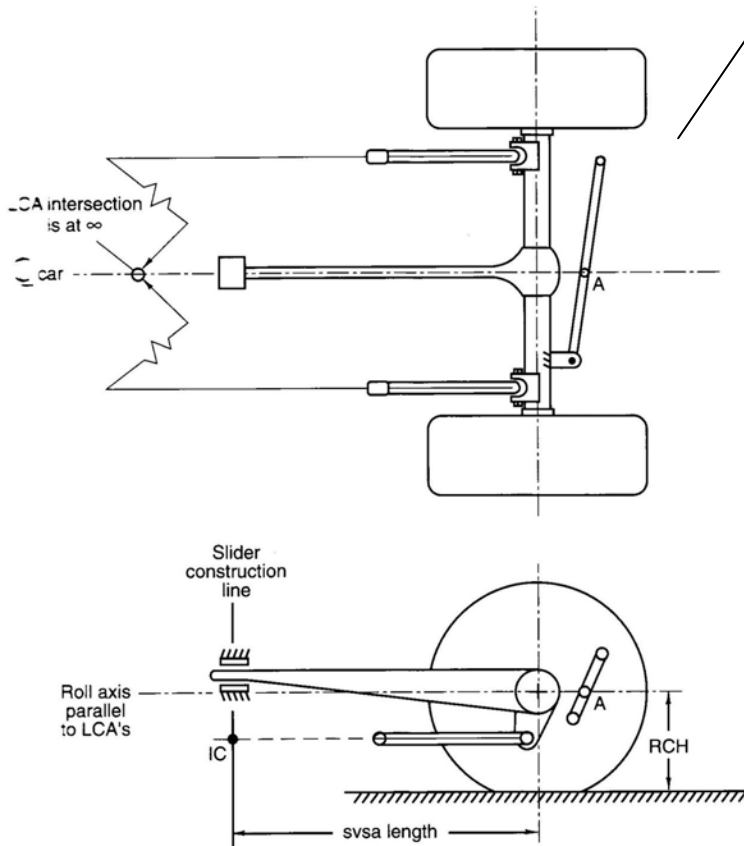


Figure 17.41 Torque arm rear axle suspension.

The Torque Arm is similar to the Torque Tube rear axle. The "ball joint" at the transmission is now replaced with a slider joint. Two lower control arms have been added to resist the axle twisting when viewed from the top (plan view). It then uses some type of lateral locating device (panhard bar shown here) to resist sideways motion. All accelerating and decelerating torque is transferred through the lower control arms.

This suspension was used in the 4th generation Camaros and Firebirds, 1993-2002.

Picture courtesy "Race Car Vehicle Dynamics" by Milliken & Milliken.

Torque Arm is an example file supplied with program for you to evaluate.

Suspension Analyzer v2.4 Performance Trends [Torque Arm]

File Edit Graphs Reports Vehicle Specs Adjust Optimize Zoom Animate Preferences Help

Front View | Side View | Top View | No View | Dynamic Squat 0 Roll 0

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

Toe-In Gain: .00" Roll Center Ht: 12.50 Turn Radius: None Roll Center Right: .00 Toe-In Gain: .00"
 Anti-Squat, Static 139.1% Dyn 139.1% Anti-Squat, Static 139.1% Dyn 139.1%

Rear Suspension

| Suspension Data | | | | | | | |
|---------------------------------|-------|------------|---------------|--------------|------------|---------------|--------------|
| Location | Type | Rt Out (X) | Rt Height (Y) | Rt Depth (Z) | Lt Out (X) | Lt Height (Y) | Lt Depth (Z) |
| Torque Arm on Frame, in | Input | 1 | 13 | 52 | | | |
| Lower Link Frame Mount, in | Input | 24 | 9 | 28 | 24 | 9 | 28 |
| Lower Link Axle Mount, in | Input | 25 | 7 | 0 | 25 | 7 | 0 |
| Pan Hard Bar (Frame = Rt Side), | Input | 20 | 13 | -8 | 20 | 12 | -8 |

Side view of Torque Arm suspension.

Program needs location of the Torque Arm and lower control arms.

Fig A 6.17 5 Link Independent Rear Suspension

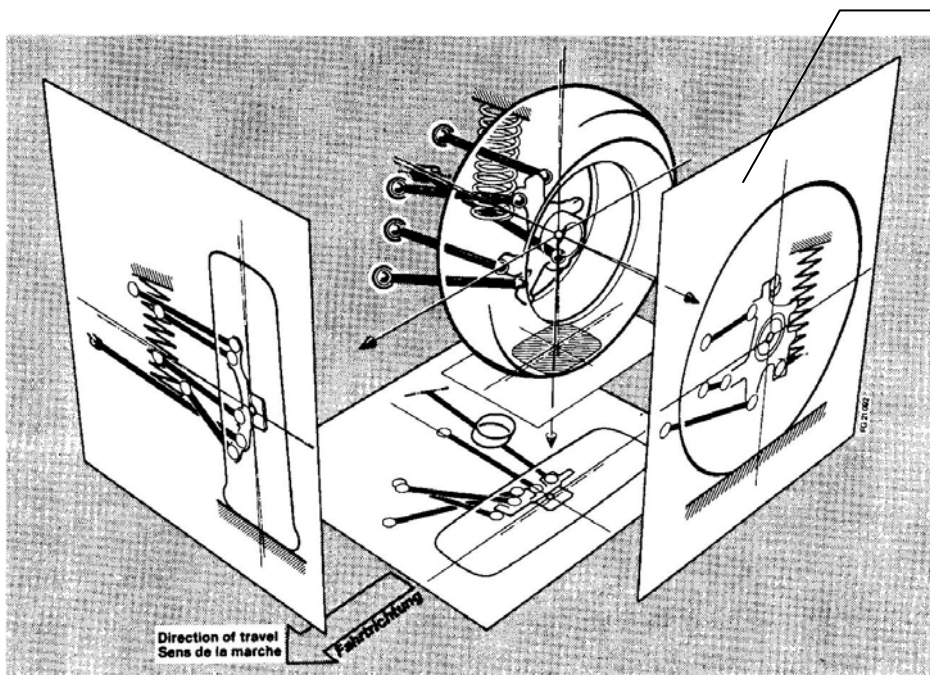


Figure 17.33 SLA suspensions—five-link Mercedes type.

The 5 Link style of independent rear suspension has 5 links with ball joints on each end. One end of each link attaches to the frame and the other attaches to the wheel spindle. This type of suspension provides lots of flexibility for designing in desired tuning characteristics. However, it can produce “bind” in not done correctly. The program will estimate the amount of bind, so you can watch for this.

The C4 Corvette, 1984-92 used this type of suspension.

Picture courtesy “Race Car Vehicle Dynamics” by Milliken & Milliken.

5 Link Rear is an example file supplied with program for you to evaluate.

Suspension Analyzer v2.4 Performance Trends [5 Link Rear]

File Edit Graphs Reports Vehicle Specs Adjust Optimize Zoom Animate Preferences Help

Front View Side View Top View No View Dynamic Squat 0 Roll 0

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

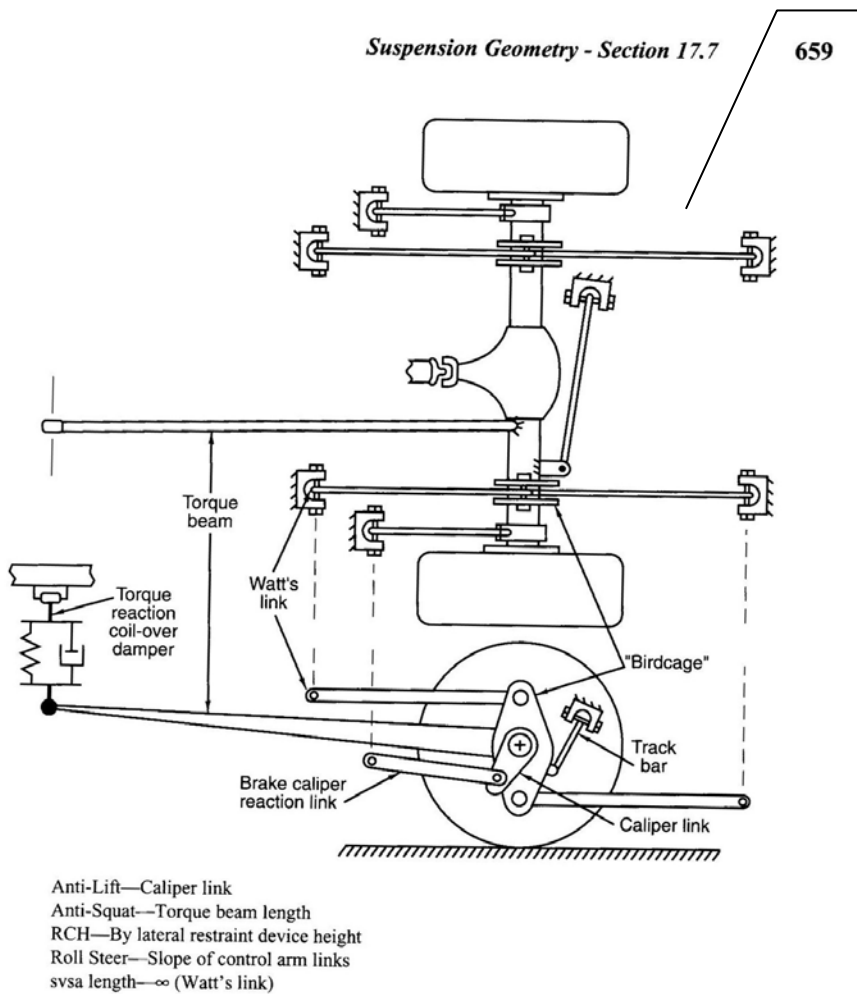
Toe-In Gain: -.20" Roll Center Ht: 3.79 Turn Radius: None Roll Center Right: .00 Toe-In Gain: -.20"
 Camber Gain: .00 Caster Gain: -.68 Caster Gain: -.68 Camber Gain: .00

| Suspension Data | | | | | | | |
|------------------------------|-------------|------------|---------------|--------------|------------|---------------|--------------|
| Location | Type | Rt Out (X) | Rt Height (Y) | Rt Depth (Z) | Lt Out (X) | Lt Height (Y) | Lt Depth (Z) |
| Upper Ball Joint, Front, in | Input (clc) | 25.039 | 18 | -1 | 25.039 | 18 | -1 |
| Upper Ball Joint, Rear, in | Input (clc) | 25.039 | 17 | -3.7 | 25.039 | 17 | -3.7 |
| Upper Frame Pivot, Front, in | Input | 23 | 17 | 21 | 23 | 17 | 21 |
| Upper Frame Pivot, Rear, in | Input | 8.5 | 17.5 | -4 | 8.5 | 17.5 | -4 |
| Lower Ball Joint, Front, in | Input (clc) | 25.5 | 6.535 | .984 | 25.5 | 6.535 | .984 |
| Lower Ball Joint, Rear, in | Input (clc) | 25.5 | 6.693 | -1.969 | 25.5 | 6.693 | -1.969 |
| Lower Frame Pivot, Front, in | Input | 23 | 7.874 | 20 | 23 | 7.874 | 20 |
| Lower Frame Pivot, Rear, in | Input | 9 | 7.52 | -2 | 9 | 7.52 | -2 |
| Tie Rod on Frame | Input | 8 | 11.654 | -3 | 8 | 11.654 | -3 |
| Tie Rod on Spindle, in | Input | 25.472 | 10.906 | -3 | 25.472 | 10.906 | -3 |

Side view of 5 Link suspension.

Program needs location of each end of the 5 links, or 10 X, Y and Z coordinates for the left and right side.

Fig A 6.18 'Decoupled' Live Axle (bird cage) Live Rear Axle



The Decoupled Live Axle is rather complex, but provides lots of flexibility for suspension tuning. The "bird cage" is the term for the brackets for the control arm links. What's unique about these "bird cage" brackets is the axle housing is free to rotate within the bracket. Therefore, the control arms do not affect anti squat. Anti-squat is completely controlled by the torque beam.

Due to its complexity, typically only circle track race cars use this type of suspension.

Picture courtesy "Race Car Vehicle Dynamics" by Milliken & Milliken.

Figure 17.42 Decoupled rear axle suspension.

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

Toe-In Gain: .01" Roll Center Ht: 9.57 Turn Radius: None Roll Center Left: 1.78 Toe-In Gain: -.01" Anti-Squat, Static 225.3% Dyn 225.3% Anti-Squat, Static 225.3% Dyn 225.3%

| Location | Type | Rt Out (X) | Rt Height (Y) | Rt Depth (Z) | Lt Out (X) | Lt Height (Y) | Lt Depth (Z) |
|---------------------------------|-------------|------------|---------------|--------------|------------|---------------|--------------|
| Upper Link Frame Mount, in | Input (clc) | 14.5 | 17.5 | 19 | 14. | 18 | 19 |
| Upper Link Axle Mount, in | Input (clc) | 17. | 18.5 | 0 | 19. | 18 | 0 |
| Torque Beam Mount on Frame, | Input | 2.299 | 14 | 44 | 0 | 0 | 0 |
| Lower Link Frame Mount, in | Input (clc) | 20 | 9 | 24 | 20. | 10 | 23. |
| Lower Link Axle Mount, in | Input (clc) | 18. | 8. | 1 | 18. | 9. | 1 |
| Pan Hard Bar (Frame = Rt Side), | Input | 18 | 9 | -7 | 17 | 10 | -7 |

Bird Cage Rear w Brackets is an example file supplied with program for you to evaluate.

Side view of Decoupled Bird Cage Rear

Program needs location of the 2 control arms for each side, and the location of the torque beam.

Fig A 6.19 Four Link Features

Click on "Input (clc)" for a particular mount to choose which side's brackets you want to edit. Screen to right will be displayed.

This screen lets you enter several hole locations for each bracket.

| Hole # | Inches Ahead of Axle | Inches Above Ground | Decimal Equivalents: |
|----------|----------------------|---------------------|----------------------|
| Hole #1 | 19 | 17.5 | 1/8 = .125 |
| Hole #2 | 19.5 | 16.5 | 1/4 = .25 |
| Hole #3 | 20 | 15.5 | 3/8 = .375 |
| Hole #4 | 20.5 | 14.5 | 1/2 = .5 |
| Hole #5 | | | 5/8 = .625 |
| Hole #6 | | | 3/4 = .75 |
| Hole #7 | | | 7/8 = .875 |
| Hole #8 | | | |
| Hole #9 | | | |
| Hole #10 | | | |
| Hole #11 | | | |
| Hole #12 | | | |
| Hole #13 | | | |
| Hole #14 | | | |
| Hole #15 | | | |

Click on a bracket hole, and instant center or pick a Hole # from the 4 bracket lists to check a particular combination.

In Side View, click on 4 Link to display "Right Side Brackets" features shown

Click here to keep your changes.

These buttons let you move all holes a certain amount of "This much".

Anti-Squat and Roll Steer characteristics of the combo you chose are shown here.

Click here to produce table of all combinations shown to left.

Click here to rank all combos by the characteristic you are most interested in.

| Location | Type | Rt Out (X) | Rt Height (Y) |
|--------------------------------|-------------|------------|---------------|
| Upper Link Frame Mount, in | Input (clc) | 14.5 | 17.5 |
| Upper Link Axle Mount, in | Input (clc) | | |
| Lower Link Frame Mount, in | Input (clc) | | |
| Lower Link Axle Mount, in | Input (clc) | | |
| Watts Link Mounts on Frame, in | Input (clc) | 18 | 12 |
| Watts Link Mounts on Axle, in | Input (clc) | | |

Right Side Brackets

Upper Frame: 1
Upper Axle: 1
Lower Frame: 3
Lower Axle: 2

IC Z (ahead of axle): 109.7
IC Y (above ground): 12.7
Anti Squat = 82.1 %
Lead Change: .030
Turn Radius = -9707 ft (Rt)

Close (keep changes)
Close (abandon changes)

| Location | Type | Rt Out (X) | Rt Height (Y) | Rt Depth (Z) | Lt Height (Y) | Lt Depth (Z) |
|----------|------|------------|---------------|--------------|---------------|--------------|
| | | | 7.5 | 19 | 18 | 19 |
| | | | 8.5 | 0 | 18 | 0 |
| | | | | 24 | 10 | 23 |

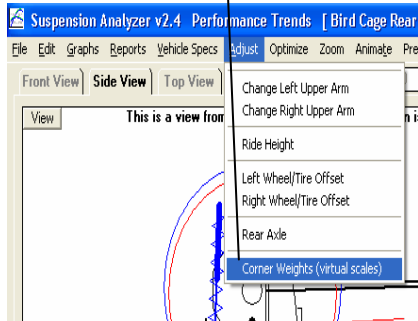
Click here to produce table of all combinations shown to left.

| Top Axle Bracket Hole | Bottom Axle Bracket Hole | Top Frame Bracket Hole | Bottom Frame Bracket Hole | Instant Center Length, inches | Instant Center Height, inches | Percent Anti-Squat | Lead Forward, inches | Turn Radius Left, feet |
|-----------------------|--------------------------|------------------------|---------------------------|-------------------------------|-------------------------------|--------------------|----------------------|------------------------|
| 3 | 4 | 1 | 1 | -994.4 | -37.3 | 26.5 | .025 | 11411 |
| 3 | 3 | 3 | 1 | 185.8 | 7.0 | 26.7 | .059 | -4929 |
| 1 | 2 | 3 | 1 | 98.2 | 3.8 | 27.2 | .122 | -2382 |
| 1 | 2 | 1 | 2 | 199.5 | 8.0 | 28.4 | .051 | -5678 |
| 4 | 3 | 4 | 1 | 168.6 | 7.0 | 29.4 | .063 | -4643 |
| 2 | 2 | 2 | 2 | 102.1 | 0.0 | 20.0 | .054 | 5412 |

Click here to rank all combos by the characteristic you are most interested in.

Fig A 6.20 Virtual Scales

Virtual Scales turned on by clicking on Adjust, then Corner Weights.



Suspension Analyzer v2.4 Corner Jacking Screen [Bird Cage Rear w Brackets]
 Back Back (keep changes) Print Help

| Jacking | | Tire Change | | Move Weight | |
|--------------------|---------------------|---------------------|---------------------|-----------------------|-----------------------|
| Left Front | Right Front | Left Front | Right Front | Left Front | Right Front |
| Threads/Inch 16 | Threads/Inch 16 | Threads/Inch 16 | Threads/Inch 16 | Threads/Inch 16 | Threads/Inch 16 |
| Turns Down 9 | Turns Down 0 | Turns Down 0 | Turns Down 0 | Turns Down 0 | Turns Down 0 |
| Static Weight 600 | Static Weight 535 | Static Weight 645 | Static Weight 435 | Static Weight 149.987 | Static Weight 149.987 |
| Spring Rate 224.98 | Spring Rate 250.015 | Spring Rate 149.987 | Spring Rate 149.987 | | |

Help Definition: Enter the number of turns from where you started, or click on the Up/Down button to toggle the reading up or down 1 turn. Where you started is the screw position which produced the Static Corner Weights shown here.

Important: The estimates made in this screen are based on several assumptions, two of the most important being the chassis is perfectly stiff and the tires are perfectly stiff.

| Left | Static | New | Rear % | Right |
|-------------|--------|-------|--------|-------------|
| Height .00" | 48.76 | 48.76 | | Height .00" |
| 51 | 56.21 | 56.21 | Left % | .04 |
| Lbs 600 | 53.27 | 51.97 | Cross | Lbs 535 |
| 614.4 | | | | 520.6 |
| Height .00" | | | | Height .00" |
| 23 | | | | -.24 |
| Lbs 645 | | | | Lbs 435 |
| 630.6 | | | | 449.4 |

Cross weight is adjusted by turning on Jacking

Suspension Analyzer v2.4 Corner Jacking Screen [Bird Cage Rear w Brackets]
 Back Back (keep changes) Print Help

| Jacking | Tire Change | Move Weight |
|---------------------------------|------------------------------|-------------|
| Tire to Change Right Front | What to Change Circumference | |
| Current Tire Circumference 74.5 | New Tire Circumference 77 | |
| Diameter 23.7 | Diameter | |

Help Definition: Enter the number of threads per inch for the jacking screw on this corner of the car.

Important: The estimates made in this screen are based on several assumptions, two of the most important being the chassis is perfectly stiff and the tires are perfectly stiff.

| Left | Static | New | Rear % | Right |
|-------------|--------|-------|--------|-------------|
| Height .00" | 48.76 | 48.76 | | Height .00" |
| .03 | 56.21 | 56.21 | Left % | -.25 |
| Lbs 600 | 53.27 | 53.90 | Cross | Lbs 535 |
| 593.1 | | | | 541.9 |
| Height .00" | | | | Height .00" |
| -.11 | | | | .12 |
| Lbs 645 | | | | Lbs 435 |
| 651.9 | | | | 428.1 |

Cross weight changes by changing tire size.

Suspension Analyzer v2.4 Corner Jacking Screen [Bird Cage Rear w Brackets]
 Back Back (keep changes) Print Help

| Jacking | Tire Change | Move Weight |
|--|--|-------------|
| Current Vehicle Weight 2215 | New Vehicle Weight 2215 | |
| Weight Change Move Weig | Weight to Move 100 | |
| Current Location Ahead/Behind of Rear Axle Ahead | New Location Ahead/Behind of Rear Axle Ahead | |
| Distance 24 | Distance 2 | |
| Left/Right of Centerline Left | Left/Right of Centerline Right | |
| Distance 16 | Distance 18 | |

Help Definition: Pick whether the weight is ahead or behind the rear axle (or a line connecting the center of the left and right rear wheels).

| Left | Static | New | Rear % | Right |
|-------------|--------|-------|--------|-------------|
| Height .00" | 48.76 | 49.68 | | Height .00" |
| | 56.21 | 53.66 | Left % | |
| Lbs 600 | 53.27 | 51.31 | Cross | Lbs 535 |
| 583.4 | | | | 531.3 |
| Height .00" | | | | Height .00" |
| | | | | |
| Lbs 645 | | | | Lbs 435 |
| 605.2 | | | | 495.2 |

All weights and weight percentages can change by moving, adding or removing weight from the car at a particular location. Program also shows new CG location and location of weight added and weight removed (or how weight was moved).

Fig A 6.21 Watts Link Features

Now the Watts Link pivot can be either on the axle housing or on the frame.

Enter just a few inputs, then click on the "Use Calc Value" button in the lower left when there is a "Yes" in the "Enough Dimensions ?" box. Program will create a typical Watts Link as shown below. From here you may want to fine tune the inputs some more.

Vehicle Specs
 Suspension Type: 3 Link, top link Right side Live Axle
 Lateral Locating Linkage: Watts Link, center link attaches to Frame
 Springs: Coil Over (outboard)
 Roll Bar: None
 Symetric Chassis (Lt same as Rt): No

Watts Link
 Enough Dimensions ? Yes
 Specs for Center Pivot:
 Distance Behind Axle: 8
 Height Above Ground: 12.5
 Center Pivot to Arm Pivot: 2
 Specs for Arms:
 Arm Length: 22
 Top Arm Goes: Right
 Note: Check Figure A6.5 in Appendix 6 for a picture of these various inputs.
 Use Calc Value Help Cancel Print

Suspension Analyzer v2.4 Performance Trends [watts pivot on frame]
 File Edit Graphs Reports Vehicle Specs Adjust Optimize Zoom Animate Preferences Help 4 Link

Front View Side View Top View No View Dynamic Squat 2 Roll 0

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

Toe-In Gain: -.01" Roll Center Ht: 12.50 Turn Radius: None Roll Center Right: .00
 Anti-Squat, Static 66.4% Dyn 66.4% Anti-Squat, Static 28.2%

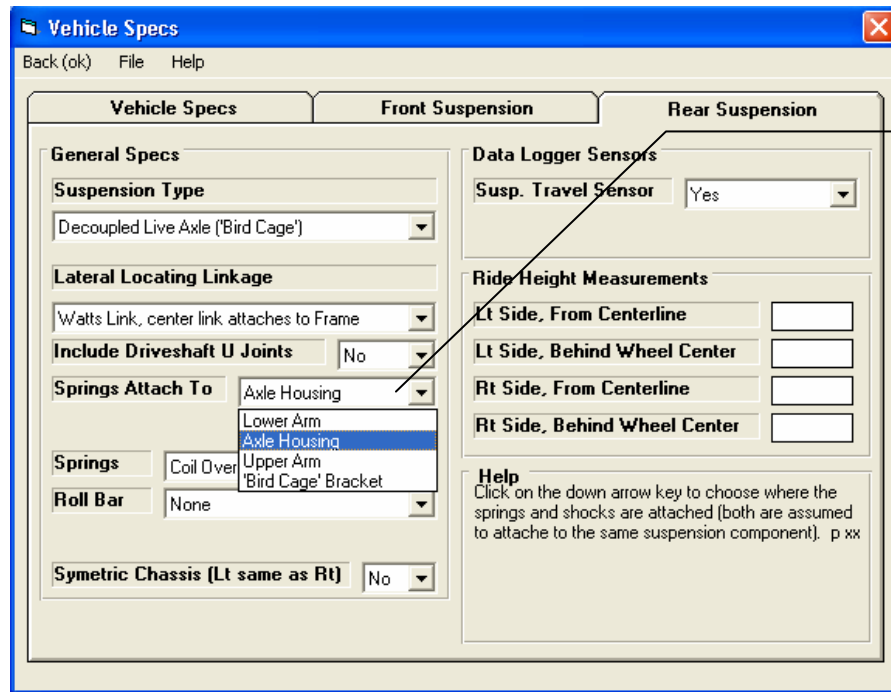
All 3 rows of Watts Link inputs have been filled, and a workable Watts Link has been drawn.

The Watts Link Wizard is the fastest way to avoid errors from a combination of binding measurements. This can occur when you have switched from a panhard bar to a Watts Link, or made some other significant change in the Vehicle Specs screen.

Click on "Input (clc)" for any of the Watts Link rows and the "Watts Link" screen in the upper right corner will appear.

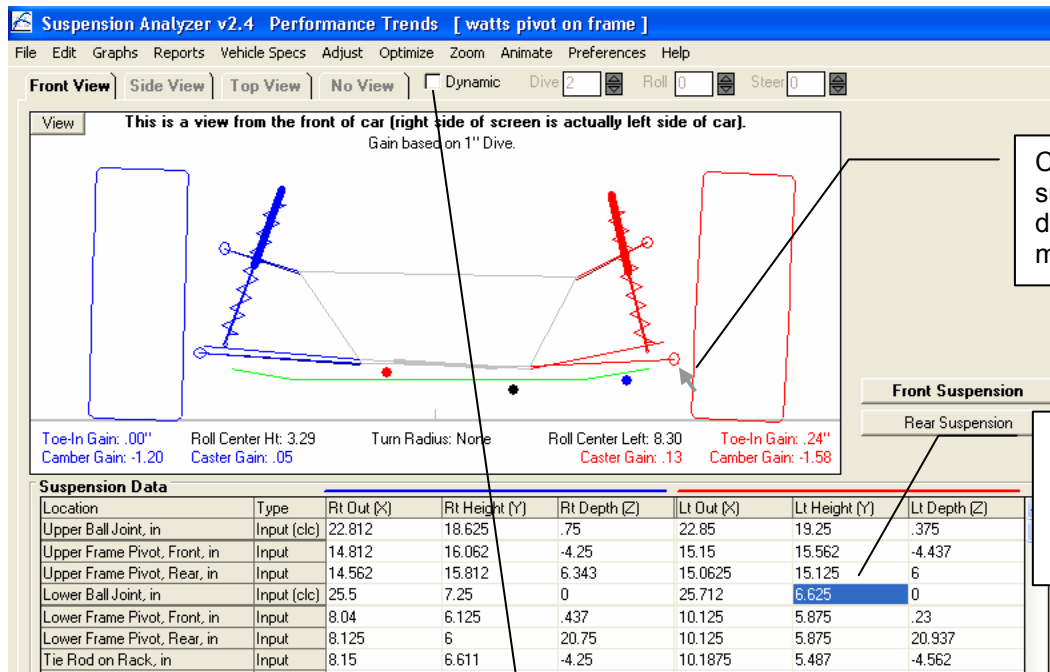
| Location | Type | Rt Out (X) | Rt Height (Y) | Rt Depth (Z) | Lt Out (X) | Lt Height (Y) | Lt Depth (Z) |
|-----------------------------------|-------------|------------|---------------|--------------|------------|---------------|--------------|
| Upper Link Frame Mount, in | Input (clc) | 0 | 20.75 | 18 | | | |
| Upper Link Axle Mount, in | Input (clc) | 0 | 24 | -3 | | | |
| Lower Link Frame Mount, in | Input (clc) | 24 | 6.25 | 28 | 24 | 5 | 28 |
| Lower Link Axle Mount, in | Input (clc) | 25 | 5 | .001 | 25 | 5 | .001 |
| Watts Link Mounts on Axle, in | Input (clc) | 22 | 14.5 | -8. | 22 | 10.5 | -8. |
| Watts Link Pivot Bar on Frame, in | Input (clc) | 0 | 14.5 | -8. | 0 | 10.5 | -8. |
| Watts Link Pivot Bar Pivot, in | Input (clc) | 0 | 12.5 | -8. | 0 | 12.5 | -8. |

Fig A 6.22 New Spring Mounts



You can now locate the spring on the upper arm for 4 link (including bird cage) type rear suspensions. Also, if Bird Cage, you can also select to mount on the Bird Cage bracket itself, the most common method for Bird Cage suspensions.

Fig A 6.23 Highlighting Cell from Clicking on Layout Drawing



Note: This features works best if the suspension is drawn at static ride height (Dynamics is turned Off).

Fig A 6.24 New View Options on Main Screen

Click on the View button for access to several commonly used Preference settings. Note: You can also change these settings in the Preferences menu.

Select to "Draw Layout Biggest Size" and the screen will be redrawn as shown below.

Suspension Analyzer v2.4 Performance Trends [watts pivot on frame]
 File Edit Graphs Reports Vehicle Specs Adjust Optimize Zoom Animate Preferences Help
 Front View | Side View | Top View | No View | Dynamic | Dive | Roll | Steel

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

- Don't Draw Extension Lines on Front View
- Draw Extension Lines on Front View
- Draw Layout Standard Size
- Draw Layout Bigger Size
- Draw Layout Biggest Size
- Side View Shows Both Left and Right Side
- Side View Shows Left Side Only
- Side View Shows Right Side Only
- More View Options
- Close This Menu

Front Suspension
Rear Suspension

Toe-In Gain: .00" Roll Center Ht: 3.29 Turn Radius: None Roll Center Left: 8.30 Toe-In Gain: .24"
 Camber Gain: -1.20 Caster Gain: .05 Caster Gain: .13 Camber Gain: -1.58

| Location | Type | Rt Out (X) | Rt Height (Y) | Rt Depth (Z) | Lt Out (X) | Lt Height (Y) | Lt Depth (Z) |
|-------------------------------|-------------|------------|---------------|--------------|------------|---------------|--------------|
| Upper Ball Joint, in | Input (clc) | 22.812 | 18.625 | .75 | 22.85 | 19.25 | .375 |
| Upper Frame Pivot, Front, in | Input | 14.812 | 16.062 | -4.25 | 15.15 | 15.562 | -4.437 |
| Upper Frame Pivot, Rear, in | Input | 14.562 | 15.812 | 6.343 | 15.0625 | 15.125 | 6 |
| Lower Ball Joint, in | Input (clc) | 25.5 | 7.25 | 0 | 25.712 | 6.625 | 0 |
| Lower Frame Pivot, Front, in | Input | 8.04 | 6.125 | .437 | 10.125 | 5.875 | .23 |
| Lower Frame Pivot, Rear, in | Input | 8.125 | 6 | 20.75 | 10.125 | 5.875 | 20.937 |
| Tie Rod on Rack, in | Input | 8.15 | 6.611 | -4.25 | 10.1875 | 5.487 | -4.562 |
| Tie Rod on Spindle, in | Input | 25 | 7.97 | -5.406 | 24.5 | 8.454 | -4.625 |
| Spring Mount on Frame | Input | 16.625 | 25 | 1.59375 | 18.937 | 24.5 | .8 |
| Spring Mount on Lower Arm, in | Input | 22.78 | 8.25 | .125 | 22.812 | 7.5 | .187 |
| Upper Sensor Mount, in | Input | 16.625 | 25 | 1.59375 | 18.937 | 24.5 | .8 |
| Lower Sensor Mount, in | Input | 22.78 | 8.25 | .125 | 22.812 | 7.5 | .187 |
| Roll Bar on Arms, in | Input | 22.1 | 5.5 | -1.312 | 22.937 | 5.5 | -1.312 |
| Spring Length, in | Output | 17.91 | | | 17.45 | | |
| Spring Angle from Front | Output | 20.18 | | | 12.84 | | |
| Spring Angle from Side | Output | 5.01 | | | 2.06 | | |
| Spring Rate/Wheel Rate | Input (clc) | 350 | 188.1 | | 345 | 146.6 | |
| Mtn.Ratio Sprng/Shck/RBar | Output | 733 | | .707 | 652 | | .655 |

Layout drawn to Biggest Size.

Suspension Analyzer v2.4 Performance Trends [watts pivot on frame]
 File Edit Graphs Reports Vehicle Specs Adjust Optimize Zoom Animate Preferences Help
 Front View | Side View | Top View | No View | Dynamic | Dive | Roll | Steel

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

Front Suspension
Rear Suspension

Toe-In Gain: .00" Roll Center Ht: 3.29 Turn Radius: None Roll Center Left: 8.30 Toe-In Gain: .24"
 Camber Gain: -1.20 Caster Gain: .05 Caster Gain: .13 Camber Gain: -1.58

| Location | Type | Rt Out (X) | Rt Height (Y) | Rt Depth (Z) | Lt Out (X) | Lt Height (Y) | Lt Depth (Z) |
|-------------------------------|-------------|------------|---------------|--------------|------------|---------------|--------------|
| Upper Ball Joint, in | Input (clc) | 22.812 | 18.625 | .75 | 22.85 | 19.25 | .375 |
| Upper Frame Pivot, Front, in | Input | 14.812 | 16.062 | -4.25 | 15.15 | 15.562 | -4.437 |
| Upper Frame Pivot, Rear, in | Input | 14.562 | 15.812 | 6.343 | 15.0625 | 15.125 | 6 |
| Lower Ball Joint, in | Input (clc) | 25.5 | 7.25 | 0 | 25.712 | 6.625 | 0 |
| Lower Frame Pivot, Front, in | Input | 8.04 | 6.125 | .437 | 10.125 | 5.875 | .23 |
| Lower Frame Pivot, Rear, in | Input | 8.125 | 6 | 20.75 | 10.125 | 5.875 | 20.937 |
| Tie Rod on Rack, in | Input | 8.15 | 6.611 | -4.25 | 10.1875 | 5.487 | -4.562 |
| Tie Rod on Spindle, in | Input | 25 | 7.97 | -5.406 | 24.5 | 8.454 | -4.625 |
| Spring Mount on Frame | Input | 16.625 | 25 | 1.59375 | 18.937 | 24.5 | .8 |
| Spring Mount on Lower Arm, in | Input | 22.78 | 8.25 | .125 | 22.812 | 7.5 | .187 |
| Upper Sensor Mount, in | Input | 16.625 | 25 | 1.59375 | 18.937 | 24.5 | .8 |
| Lower Sensor Mount, in | Input | 22.78 | 8.25 | .125 | 22.812 | 7.5 | .187 |
| Roll Bar on Arms, in | Input | 22.1 | 5.5 | -1.312 | 22.937 | 5.5 | -1.312 |
| Spring Length, in | Output | 17.91 | | | 17.45 | | |
| Spring Angle from Front | Output | 20.18 | | | 12.84 | | |
| Spring Angle from Side | Output | 5.01 | | | 2.06 | | |
| Spring Rate/Wheel Rate | Input (clc) | 350 | 188.1 | | 345 | 146.6 | |
| Mtn.Ratio Sprng/Shck/RBar | Output | 733 | | .707 | 652 | | .655 |

Fig A 6.25 Ball Joint Wizard

Click on "Input (clc)" to open the Ball Joint Wizard shown to the right.

This is the center of the ball joint's rotation, the numbers the program needs.

These are the measurements you entered into this screen.

| Location | Type | Rt Out (X) |
|------------------------------|-------------|------------|
| Upper Ball Joint, in | Input (clc) | 22.812 |
| Upper Frame Pivot, Front, in | Input | 14.812 |
| Upper Frame Pivot, Rear, in | Input | 14.562 |
| Lower Ball Joint, in | Input (clc) | 25.5 |
| Lower Frame Pivot, Front, in | Input | 8.04 |
| Lower Frame Pivot, Rear, in | Input | 8.125 |
| Tie Rod on Rack, in | Input | 8.15 |
| Tie Rod on Spindle, in | Input | 25 |

Same screen as above, but after clicking on "Side View" button.

Fig A 6.26 Jacking Component

Turn On in Preferences.

C.G. Position Left/Right

Right Jacking Component

Left Jacking Component

Static and Dynamic Jacking Component shown here in results.

Program is in Animate mode using a data logger file. This "Full Vehicle w Data Logger" feature allows you to watch the Roll Center and Roll Axis change dynamically, and also draws the CG (Center of Gravity) location dynamically. This feature was used in this illustration ONLY because it drew in the CG location to illustrate the definition of the Jacking Component.

| Location | Type | Rt Static | Rt Dynamic | Rt Change | Lt Static | Lt Dyna |
|----------------------------------|--------|-----------|------------|-----------|-----------|---------|
| Anti Dive, % | Output | -7.7 | -1.3 | -.6 | 7.7 | 7.9 |
| Jacking Component, in | Output | 2.92 | 2.86 | -.06 | 3.91 | 3.65 |
| Upper Arm Len True/Frnt/Rr, in | Output | 8.55 | 9.78 | 10.36 | 8.66 | 9.80 |
| Lower Arm Len True/Frnt/Rr, in | Output | 21.25 | 10.3 | 27.09 | | .0 |
| Spindle Length, in | Output | 28.04 | .4 | | 28.02 | -.3 |
| Tie Rod/Steering Arm Length, in | Output | 94.00 | .0 | | 14.62 | 4.75 |
| Front View Swing Arm Length, in | Output | 54.0 | 48.9 | -5.1 | 38.7 | 38.9 |
| Side View Swing Arm Length, in | Output | .0 | 1930.3 | 1930.3 | .0 | 454.9 |
| Total Roll Stiffness, ft-lbs/deg | Output | 1414.6 | | | | |
| Front Roll Couple/FLLD, % | Output | 76.11 | | | 49.13 | some |

