ChassisSim
The Winner's Edge

The ChassisSim Cookbook.

So you have downloaded your demo version of ChassisSim or even better yet bought your copy of ChassisSim and your thinking this is great but what do I do? Whether you're new to racecar simulation or your transitioning from another simulation package this is the article for you.

The purpose of this guide is to break down step by step what you need to do to go from a blank sheet of paper to having a vehicle model that can be used in anger. What will be presented here is a checklist of everything you need to go through. As you will see vehicle modelling isn't actually that difficult. It's just a lot of attention to detail and patience.

Use this document as a checklist. It is written in sequential order of things that need to be done so think of this like a cookbook. This is also something that doesn't need to be done in one session. You can start it, do a bit and return to it later. What counts is the order you do things in. While this won't deliver the perfect vehicle model, it will deliver you something useable and will be an invaluable aid in getting you familiar with ChassisSim.

Step – 1 Initial Modelling and setting up your initial model

The first step is to measure up the racecar. While this might sound perfectly obvious this is something you must get right. If you don't you will be forever chasing your own tail. Fortunately I wrote an article in Racecar Engineering about this. The link is,

http://www.chassissim.com/blog/chassissim-news/how-to-measure-up-a-racecar

However the highlights are,

- Measure tracks and wheelbases.
- Measure the suspension geometry.
- Measure the car masses and centre of gravity height.
- Determine the aero map

The determination of the aeromap is a vital step in deducing the race car model. I wrote at length in Racecar Engineering on how to deduce this. That being said if you need something to get going a simple hand calculation at the end of the main straight will be sufficient to get you started.

The next step is to choose one of the ChassisSim default models and modify to it your needs. To do this start ChassisSim and chose one of the car templates. All you need to do is go to the right hand side of the screen and where it says Car. Click on the drop down box where you see the car name. This is the currently loaded template. A dialog will come up and choose one of the cars that most closely resemble your car.

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When you have selected this save the car file. To do this all you have to do is go File->Save As and then save this as whatever name you wish and place it in a directory of your choosing.

At this point it would be prudent to discuss the role of ChassisSim templates. When you select a car from the ChassisSim template menu, you are doing the following,

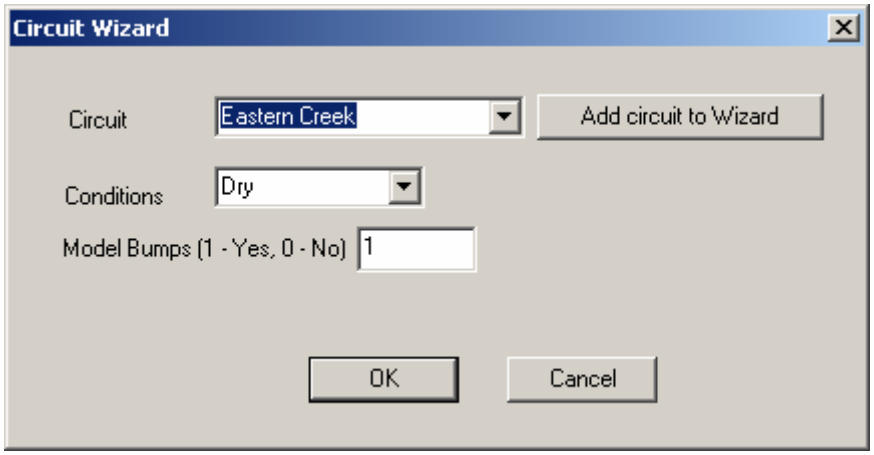
- Loading a car file that contains a particular setup and all the modelling information that describes your racecar.
- You are loading an ini file that contains the choices of springs, bars, suspension geometry and wings that pertain to your car.

However the car file that we just saved contains the model and your specific setup information. The template simply associates a car file with a representative choice of setup variables that pertain to your car. When the model is better sorted you then construct the template.

The next step is to select the units you want to setup the vehicle model in. This is selected by selecting View->Select units to use. This will form the basis of how spring rates, suspension geometry lengths and other items of apparel are entered.

Once we are at this point you simply enter the vehicle parameters. To do this all you have to do is to drag your mouse over the appropriate car component and click on it. This will bring up the appropriate dialog and you simply fill in the parameters. The specifics and order in which the vehicle parameters are entered are discussed in detail in CSim_lite_qstart.pdf for lite users or CSim_std_qstart.pdf for standard users. It is highly recommended you read this document. This is located in the ChassisSim help directory.

When the car file is completed run a preliminary simulation to ensure that everything is working correctly. To do this go to the right hand side of the screen and click on Track drop down dialog box. This will bring up the following dialog,



Select the options as shown above and select OK.

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To start the first simulation click on the Start button on the main simulation screen. This will bring up the Simulation window and all you need to do is press the Start Simulation button. This will start the simulation process and if successful you will see a lap time echoed back to you.

Once the initial simulation has been completed you are now ready to create your own circuit map and use the ChassisSim toolboxes to fill in the details on the vehicle model.

Step – 2 Creating the Monster Import File

The first step is to use your logged data to create a monster import file. This monster import file contains all the information that ChassisSim needs to create a circuit and bump profiles and run the toolboxes. This data is taken from a flying lap of the data at speed exported at 50Hz. The format of the file is an ASCII tab delimited file of the data with no headers and footers. The data that is required is,

lap distance (m)
rpm
ay (g)
ax (g)
damp front left (mm)
damp front right (mm)
damper rear left (mm)
damper rear right (mm)
steering (deg) – This is the angle of the tyre as opposed to the steering wheel.
throttle pos (%)
Vehicle speed (km/h)

If you have strains,

Strain Front Left (kgf)
Strain Front Right (kgf)
Strain Rear Left (kgf)
Strain Rear Right (kgf)

These are added at the end of the other listed parameters. What it would look like in a file is shown below,

Without loads,

0	7392.94	-0.03	0.1	4.65	4.87	5.51	5.57	0	100	207.92
1.174	7395.56	-0.03	0.11	5.01	4.58	5.16	4.72	0.03	100	207.99
2.346	7398.33	-0.02	0.11	5.08	4.85	5.98	6.57	0.06	100	208.07
3.52	7401.26	-0.02	0.12	4.83	4.81	10.52	11.16	0.08	100	208.15
4.693	7404.28	-0.02	0.12	3.93	3.96	13.22	13.3	0.09	100	208.24

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5.867	7407.27	-0.02	0.12	4.07	3.72	12.74	12.42	0.1	100	208.32
7.042	7410.23	-0.02	0.12	6.22	5.88	13.07	12.63	0.06	100	208.4
8.217	7413.14	-0.03	0.12	5.77	5.69	11.26	11.23	0.02	100	208.49
9.392	7416.04	-0.03	0.12	5.52	5.44	10.26	10.61	-0.01	100	208.57
10.568	7418.92	-0.03	0.11	7.27	6.85	11.73	11.65	-0.03	100	208.65
11.744	7421.78	-0.04	0.11	7.36	6.88	12.43	11.88	-0.03	100	208.73
12.921	7424.61	-0.05	0.11	5.72	5.62	10.39	10.2	-0.01	100	208.81
14.098	7427.42	-0.05	0.11	5	5.05	8.36	8.39	0.01	100	208.89
15.276	7430.27	-0.05	0.11	6.46	6.37	8.75	8.48	0.03	100	208.97
5865.339	7392.94	-0.03	0.1	4.65	4.87	5.51	5.57	0	100	207.92

With loads the file looks like

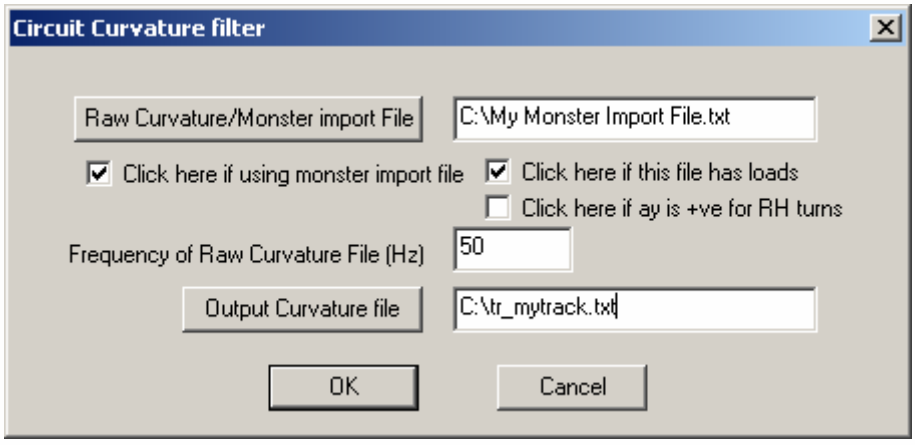
```
0      7392.94   -0.03 0.1      4.65  4.87 5.51 5.57   0 100   207.92 166.98 157.86 216.53
         202.85
1.22   7392.94   -0.03 0.1      4.65  4.87 5.51 5.57   0 100   207.92 166.98 157.86 216.53
         202.85
4.55   7392.94   -0.03 0.1      4.65  4.87 5.51 5.57   0 100   207.92 166.98 157.86 216.53
         202.85
```

Please note the distance vector needs to have at least 2 decimal places. This is very important.

Step – 3 Curvature and Bump File creation

Now we have the monster import file we can now create the curvature and bump profile.

Go to Circuit->Filter Curvature file. This will bring up the following dialog,



To import the monster import file, click on the Raw Curvature/Monster Import File and navigate to your monster import file. Click on the monster import file check box and if you have loads click on the check box as illustrated. Input the frequency of the Monster import file, and click on Output Curvature tab to indicate the file you want this written to.

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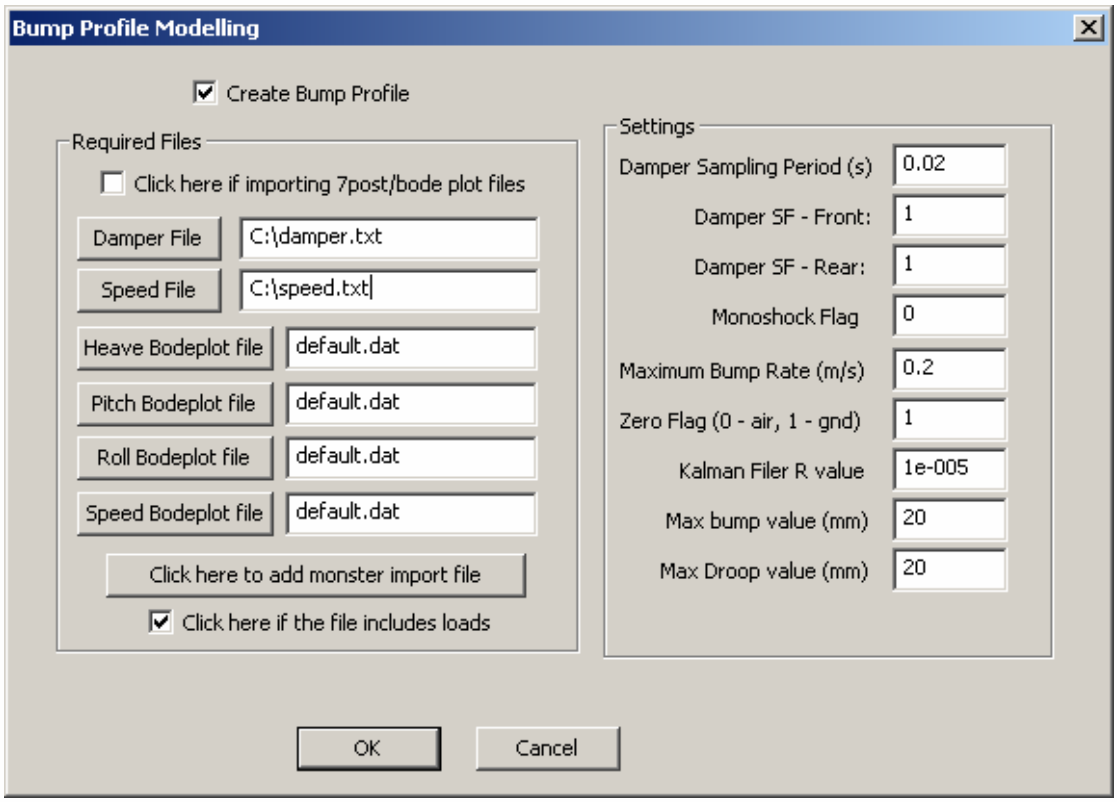
Just a note on track naming. My personal convention for curvature files is tr_trackname.txt. You can use any convention you wish just be consistent!

To generate the bump profile, Load in your setup and go to Simulate->Generate Bump Profile. This will bring up the following dialog,



If your monster import file has loads, click on the checkbox that says Click here if the file includes loads. Then click on the Monster import file tab. This will automatically populate the Damper and Speed file as shown. Click on the Create bump profile tab. I've also shown the typical baseline settings you need to create a bump profile with. Once these settings are entered, click on OK.

The next step is to go to Simulate->Simulate or click the start button. This will bring up the simulation window. Click on Start simulate tab. This will generate the bump profile. The bump profile will be saved in the same directory as the current car file. If you're generating it using one of the templates, then it will be in the same directory as the ChassisSim executable. The file will be called bump_profile.dat. Re- name this to a file of your choice. My convention is bump_profile_trackname.dat.

When done go back to Simulate->Generate bump profile, and click of the generate bump profile check box and click OK.

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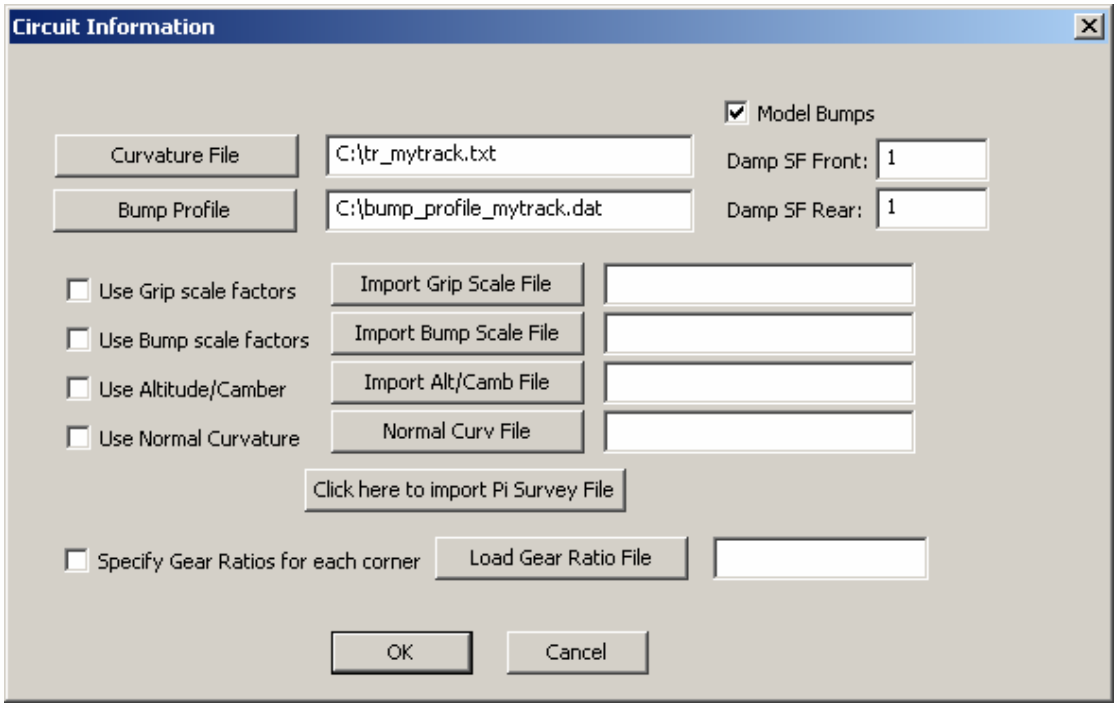
Step 4 - Loading in your curvature and bump profile

To run your curvature and bump profile go to Circuit->Circuit Data. This will bring up the following dialog,



Click on the Curvature file tab to navigate and load in your desired curvature file. The same process is applied for the bump profile. Note however in the file dialog to change the file filter to *.dat.

Once you have done this click on OK.

You are now ready to run the simulation. To do this go to Simulate->Simulate or click the Start button. This brings up the simulation dialog. To start the simulation click on Start simulation tab. The simulation will now run.

Step – 5 Exporting Simulated data to a data logger

Overlaying actual to simulated data is one of the most important tasks you can perform when validating your simulated data. Fortunately this is really simple with ChassisSim. To set this up all you have to do is select Simulate->Data logging options. This will bring up the following dialog,

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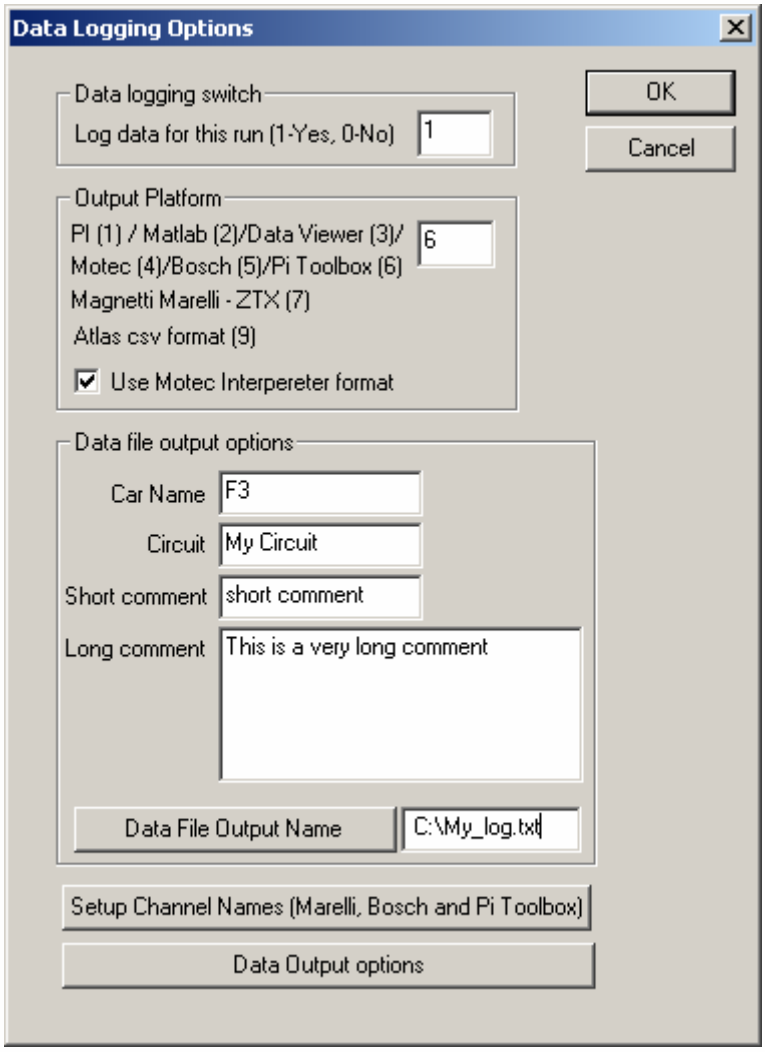

As can be seen it's pretty obvious what you put in what. In terms of file extensions to set up this is outlined below,

Analysis package	File extension
PI V6 Analysis/Atlas	*.csv
Pi Toolbox/Bosch WinDarab	*.txt
Motec	*.ld
WinTax 4	None needed

When OK is selected the data will be exported for your inspection.

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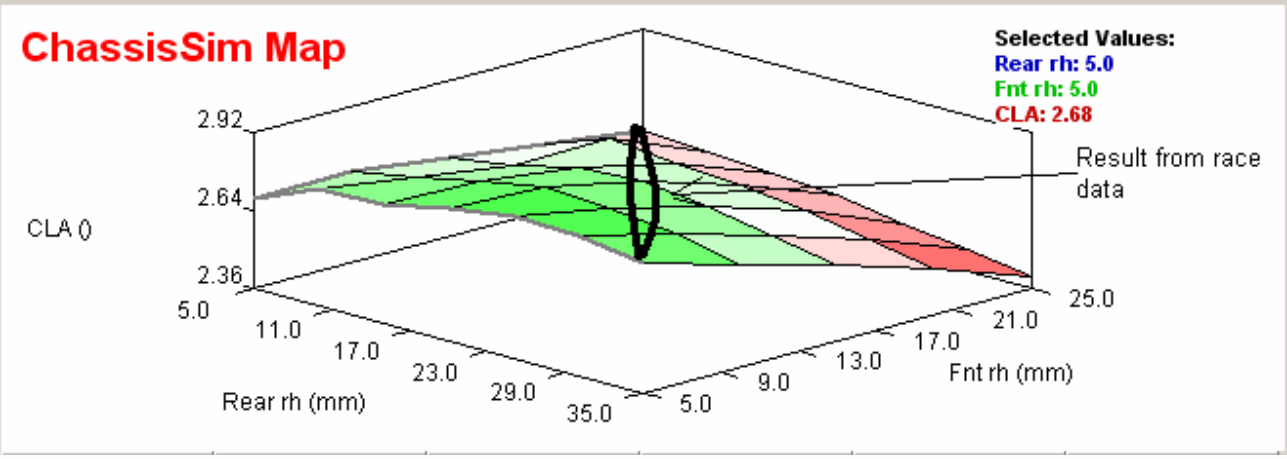
Step 6 - Using the toolboxes to reverse engineer the vehicle model

If you have got to this point you are now ready to use the ChassisSim modelling toolboxes to further refine the vehicle model.

The first toolbox will help you reverse engineer the aeromap of the car. As the car is driven around the circuit it will return a thin sliver of the aeromap. This is illustrated below,



Unfortunately you can't determine the whole aeromap from this thin sliver. Mathematically it simply is not possible. However if you put enough of these thin slivers together an aeromap can be generated. Fortunately with the ChassisSim aero toolbox you can do both.

The first step is to generate a thin sliver of the aeromap. To do this you need the monster file and you need to load the car file that represents the setup that the monster file came from. To access this what you need to do is Select Simulate->AeroModelling. This will bring up the following dialog.

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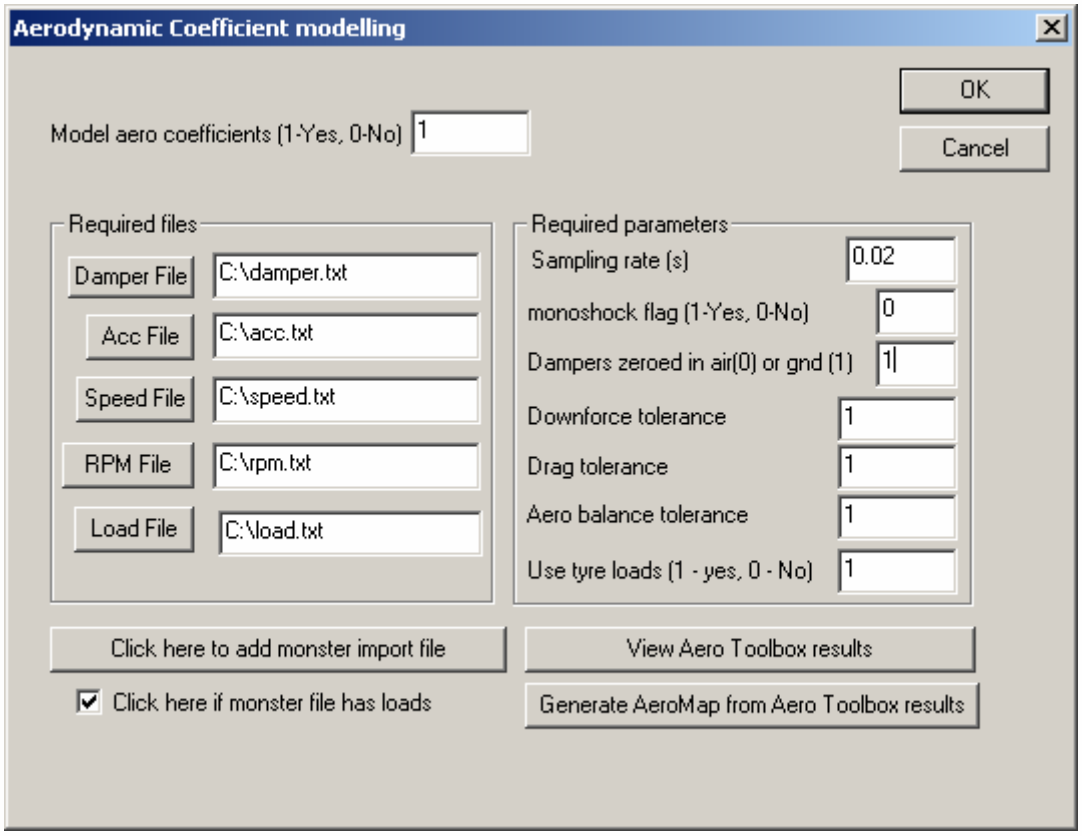

Click on the tab that says import the monster import file. If it has loads click on the checkbox first and then import the monster file. Indicate if you want to use loads, indicate if the loads and dampers are zeroed on the ground, and click to 1 to model the aero coefficients. Then click OK

This will return you to the ChassisSim main window. Click on the Start button and click on the start simulation tab. This will generate a file called aero_analysis_results.dat . This will be in the same directory as the car file. Its format will be,

Front ride height (m), Rear ride height (m) C_LA, C_DA, aero balance/100

This is an ascii file.

If you do this over a number of setups with the same wing configuration your now in a position to generate an aeromap. What you do is you get all the different aero_analysis_results.dat and combine them in a single file. You are now ready to generate an aeromap. The more of a spread of the ride height envelope you have the better the aeromap will be. To do this bring up the aeromap modelling window and click on the tab that says Generate AeroMap from Aero Toolbox results. This will bring up the following dialog,

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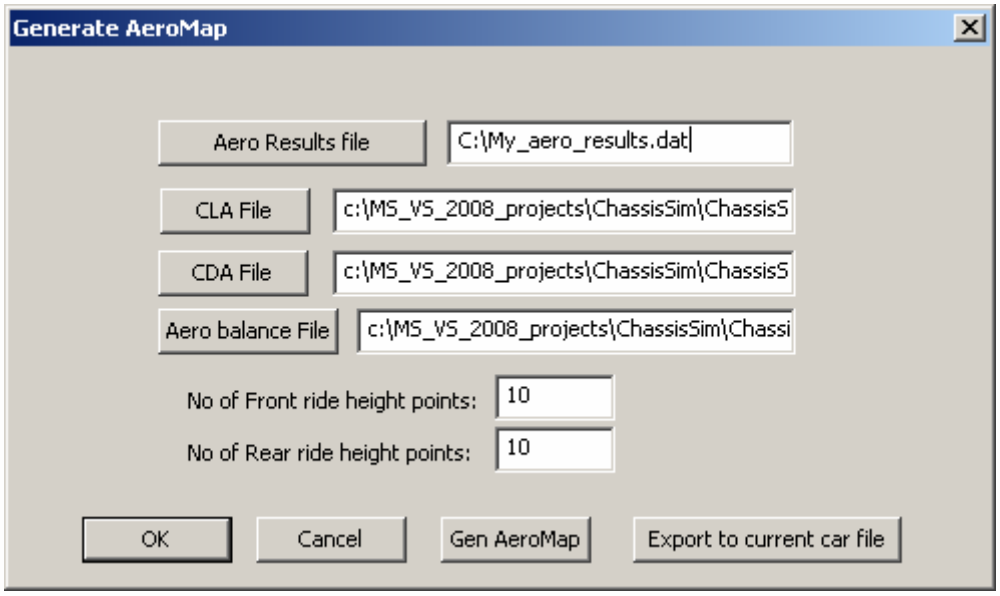

You have the option to generate separate C_LA, C_DA and aero balance files for your inspection. This will show you the ride heights and the results. However you can't import these straight into the aeromaping dialog when you edit the aeromaps. These have been supplied for sanity checking. However you can export this straight to the current car file by clicking on the tab that says Export to current car. When you click on this will update the car file with all aspects of the generated aeromap.

Once you have a good aeromap you are now ready to reverse engineer the tyres. What you need to do to use this toolbox is the following,

- Load in your curvature and bump profile in Circuit->Circuit Data
- If the circuit has significant on camber and altitude variations this also needs to be loaded in Circuit->Circuit Data

You are now ready to perform the tyre force modelling. To do this select Simulate -> Tyre Force modelling. This will bring up the tyre force modelling toolbox, which is shown overleaf. As always we use the monster import file and of course click on the does this file include loads checkbox if the file includes loads. I should add at this point please ensure the steering angle is calibrated in degrees at the tyre as opposed to the steering wheel. This is very important.

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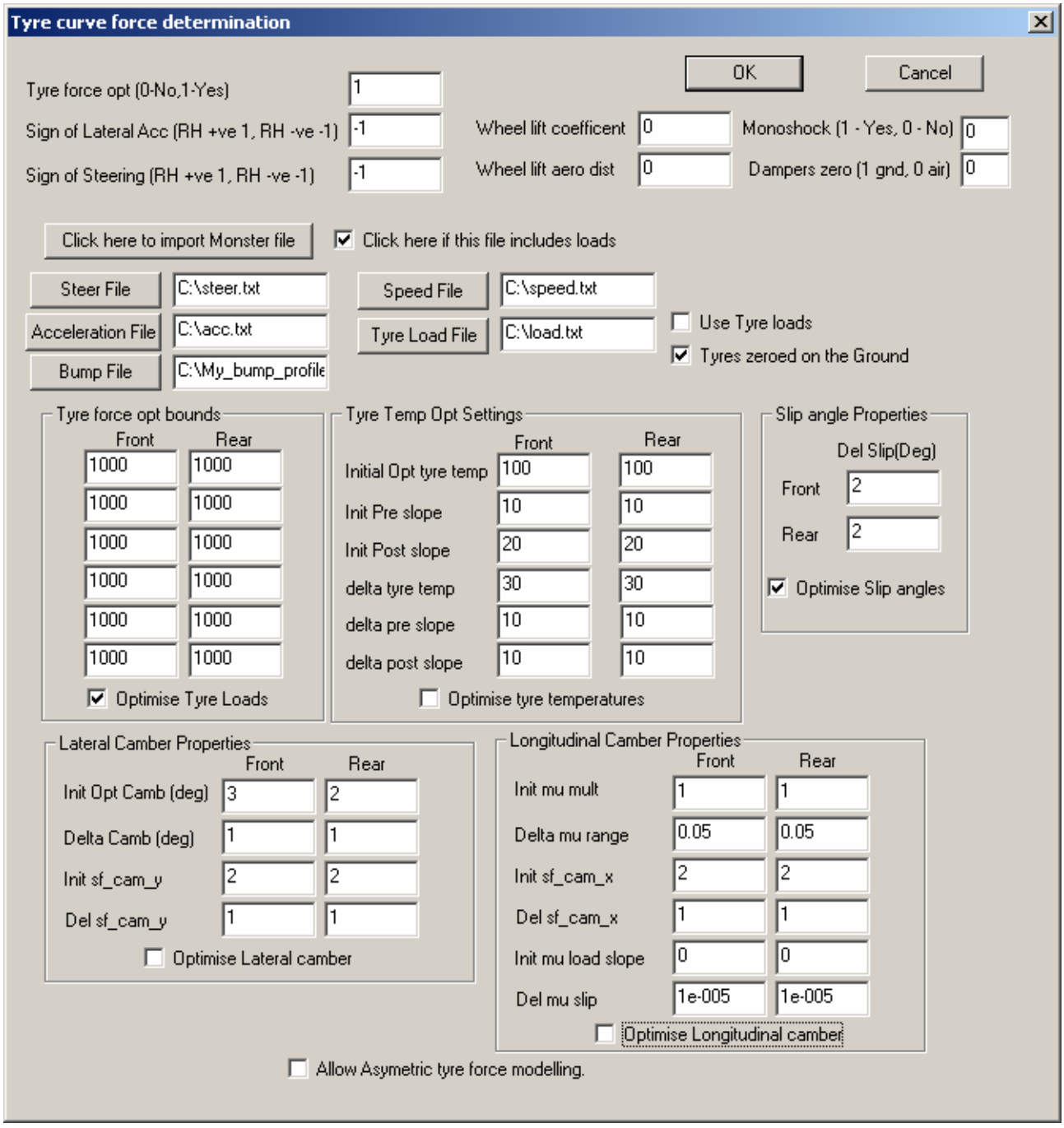

The next option we need to configure is the sign of the lateral acceleration and steered angle from the data. If the lateral acceleration and steering angle is positive for a right hand turn then both these flags are entered as 1. In the example both these signs are set to –1 which means that this data has positive steer and lateral acceleration for a left hand turn.

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Once we have this configured we need to indicate what we want to optimise. It depends on what you want to do. If you want a rough ball park, simply select Loads and slip angles and leave the other options blank. If your logged tyre temperatures are reasonable then this can be optimised as well. For your first tyre optimisation leave the lateral and longitudinal cambers unchecked. You can recheck this once you are more familiar with the ChassisSim v3 tyre model.

Once you are ready click 1 to optimise the tyres and press OK. Then click on the Start simulation button to bring up the simulation window and click start simulation. This will start the tyre force optimisation. Be warned this will take at least a couple of hours so this is an over night job.

When the tyre force optimisation is done it will output the results in a series of files in the same directory as the car directory. The front tyre force output file is called Opt_fnt_tyre_file.txt and the rear tyre force output file is called Opt_rear_tyre_file.txt. Once again the user is advised to rename these files once the optimisation routine is completed. To import these into ChassisSim, click on the relevant tyre and click on the tab that says click here to import optimised tyres/v3 approximation.

Conclusion

What has been presented here is a road map for how to get going with ChassisSim. This will take you from a blank sheet of paper to a model that can be used at the racetrack. While the model generated from here won't be completely perfect it will give you a very good baseline that you can refine as you get used to ChassisSim and race car simulation in general. The check list that has been presented has been generated from applying ChassisSim in the field so it should serve you well.

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