ADAMS/Car Learning Guide

ME 591 Course
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ADAMS/Car Learning Guide

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ADAMS/Car Tutorial Preface:

ADAMS/CAR can be a very useful tool in looking at the overall performance of a vehicle. Major auto manufacturers use this software to model every dynamic maneuver of their vehicles before a single part is ever made. This tool can be used in two different ways. The first way is to fully model every part of the vehicle. This leads to a very accurate simulation of the vehicle and thus represents real world handling that can be expected out of a production vehicle. The second method is more of a comparative analysis to investigate how design changes affect vehicle handling. The second method is more appropriate for UA Formula and Mini Baja programs, as well as students in the Vehicle Dynamics class.

Ideally, a Formula or Baja team would model the entire vehicle down to the last nut and bolt, thus their simulation would predict accurately how the vehicle will handle once built. The problem lies in the model itself. There are no accurate models of Formula tires or Baja shocks that are readily available. These models come from testing, and can be slowly added to the car model as they are produced. The most logical progression for both Formula and Baja is the Crawl-Walk-Run method introduced by MSC Software:

First, begin by modeling your subsystems and assemblies. Use your CAD drawings to move all of the hardpoints ("hardpoints" will be defined in a later tutorial) of the FSAE or Baja model to mimic your current design. Modify the spring and shock files so they somewhat match the components to be installed on the vehicle. Set the steering ratios and suspension parameters to match those of your design. Now, you enter mass and inertial properties of the entire vehicle. This is enough data to perform suspension simulations. These simulations will help you to refine your Ackermann and suspension performance.

Next, perform gross full vehicle analyses. You will not be looking to accurately represent the exact dynamic performance of your design, only to compare different subsystem performances. For example, start with the default Baja model. Modify the subsystems (front and rear suspensions) so they match your design. Run some full vehicle analyses to create a baseline. Now, change the suspension subsystems to represent alternative designs and run the same simulations as before. This will allow you to compare different designs in a qualitative manner. It will not tell you that your vehicle will travel around a 100 foot radius curve at 1.1 G’s, but it will show you which suspension will perform better than the others. These basic full vehicle simulations will also allow you to estimate maximum forces in suspension components so that control arm materials, spherical joints, and fasteners can be sized.

Finally, perform testing to refine your full vehicle model until it accurately represents your design. This will involve many hours of research and testing. Each suspension part will need inertial properties, tires and shocks will have to be modeled, and engine and drivetrain parameters will have to be determined. This will take time and experience, but is achievable. The wonderful result of this painstaking work will be accurate simulations of your designs before the first frame tube is cut. This will greatly reduce the errors and “design on the fly” situations experienced by many Formula and Baja teams.
The other significant part of learning ADAMS/CAR in the above manner is the prospect of finding a job using the software. Most every manufacturer in the transportation industry uses some form of ADAMS. This experience may help you land that dream job designing and simulating suspensions for an automaker or race team.

These tutorials are guides to help you hit the ground running with ADAMS/Car. There are many other useful ADAMS products that are necessary for furthering your vehicle analyses. If you want to greatly modify the pre-made templates, you must use ADAMS Template Builder. This will allow you to build new templates and drastically change the existing ones. If you wish to improve on the basic outdated tire model used in the Formula and Baja templates, you must use ADAMS/Tire. Likewise, ADAMS/Chassis and ADAMS/Engine will help you to refine your chassis and engine models. Also, ADAMS/Flex can help you model the elements in your vehicle that are assumed to be rigid, such as control arms and the frame. Finally, ADAMS/Insight can help you iteratively test many different suspension setups without the manual labor of ADAMS/CAR. These packages are far beyond the scope of these tutorials, yet will be essential for an accurate full vehicle model.

Problems and known errors:

- The full vehicle model labeled MDI_Concept_Vehicle does not work with full vehicle simulations because it does not have a drivetrain. If you want to use a demo vehicle for any reason, use the MDI_Demo_Vehicle.
- The Mini-Baja model uses a Fiala tire model produced with ADAMS/Tire. The full-vehicle Mini-Baja model will not simulate with the Fiala model. U of A did not purchase ADAMS/Tire so the tire properties must be swapped to the Pacjeka ’89 model for full vehicle simulations. See the Wheels and Tires tutorial for directions on exchanging tire models. After this error is fixed, the Mini Baja model simulates correctly.
- The Building A Track tutorial will help you create your own track. When simulating on this track, the SmartDriver simulation will not work at the vehicle limits for any vehicle. In the user forums, MSC admits there are known issues with SmartDriver, but they offer no solutions. 3D Road simulation is the ideal simulation to run on the 3D track, but there is no good information on creating the *.dcd and *.dcf files needed to make the simulation work. Further research is needed in this area.

What works:

- Modifying the Formula and Baja models, as well as all of the MSC templates.
- Suspension analyses with all of the aforementioned components
- Full-vehicle analyses with Formula, Baja, and Demo vehicles using the ”canned” analyses such as the ISO lane change, acceleration, braking, and steady state cornering.
Stuff you need to know:

1. ADAMS/Car is very powerful and can be useful in the design of a vehicle, but it is not the kind of software you can learn in one day. Go through ALL of the tutorials before you even begin to use ADAMS/Car to analyze your design.

2. You don’t need to import any of your CAD drawings or solid models. ADAMS/Car uses three dimensional points to define the connections and links of a vehicle’s systems. The software will generate generic solids to represent each component such as shocks, pushrods, bell cranks, etc… The data you provide must include these pivot locations which are called hardpoints. Hardpoints define the key locations of the components like the spherical joints on a control arm. The tutorials will guide you through moving and defining hardpoints. Your CAD model will be necessary in providing 3D locations for all of the hardpoints.

3. Don’t start from scratch. Open an existing model (like the FSAE and Mini-Baja templates) and modify each component to match your design. You will move hardpoints, change spring properties, modify tire parameters, and define mass and inertial properties for your design.

4. After you have defined your suspension as best you can, you should run suspension simulations to verify the following: There is no interference or binding with any of your parts throughout suspension travel and steering travel, verify design parameters such as wheel rates, Ackermann steering, and roll center height. You should also see how parameters like bump steer and wheel rates change in certain dynamic movements.

5. After all of your suspension systems have been tested and verified, it can be helpful to run full vehicle simulations. This can be a lane change, a jump, a closed racecourse, or a skidpad. This will allow you to compare several different suspensions or just compare things like different springs, tires, suspension motion ratios, etc. The idea is to run a full vehicle simulation, change one parameter, then run the exact simulation to see if you improve outputs like max lateral accelerations or avoiding bottoming out over a jump

6. Know your limitations. Spring, tire, bushing, and shock models are very important, and can be derived from testing. Be aware that your model is limited by the accuracy of input data.

7. Watch your units. Always make sure the system and vehicle units are set to a form you are comfortable using.

8. While you are viewing anything within ADAMS/Car, it may be useful to alter your view of the objects on the screen. Holding down the “z” key while holding down the left mouse button and dragging the mouse will zoom in or out on the screen, depending on the direction you move the mouse. Doing the same with the “r” key will rotate the view. Likewise, the “t” key will translate the view.

9. ADAMS does not automatically let you browse for a file when you are opening something. If you are prompted to type the name of a file you wish to open, you can double click within the text entry field and a file browsing window will appear.

10. Log onto www.mscsoftware.com/university and register with their technical support so you have access to the latest FSAE and Baja templates and the online knowledge base forums.
11. If you have questions, search the forums and help files for ADAMS/Car and look on the Mini Baja or FSAE forums. There are a lot of schools using this software to analyze vehicles, so more than likely someone has dealt with your problem before.

12. Utilize your sources of information. Inside of ADAMS/Car you can press the F1 key for information on entering data into dialog windows. To access the help files from inside ADAMS/Car click Help>ADAMS/Car Help. The help file has extensive information related to ADAMS/Car. When you register with MSC you will have access to the Knowledge Base and User’s Forum. The Knowledge base contains information on known issues. The User’s Forum is a user supported help group. Expert users from around the world routinely search new posts and provide help to others. University students are only permitted to post to the University Forums. Before using University Forums see the first two posts made by the moderator JRyan on using the forums and forum courtesies. Be sure to do your homework by searching all other information and other posts before posting. If you have exhausted all of your resources Dr. Sutton has access to MSC technical support. Requests for support will have to go through Dr. Sutton.

13. The university faculty representative (Dr. Sutton) has access to the training materials from the ADAMS/Car training course ADM 740. Dr. Sutton can provide you with copies. These materials go through all of the aspects of building models, modifying models, and simulating in ADAMS/Car. The Creating and Simulating Full Vehicles tutorial has been provided in the Appendix.

14. MSC advocates a Crawl-Walk-Run approach to simulations. ADAMS has a steep learning curve and it will take time to develop the skill and knowledge to do extensive modeling and simulation.