EDC

Technical Newsletter

HVE & *HVE-2D* Version 5.20 - Now Available

Version 5.20 was released on February 1, 2007 and was shipped as an update to all users with current Update/Technical Support policies. Users who have not received their updates should contact EDC Customer Service for assistance.

New Features and Enhancements

Version 5.20 offers users the new features described below:

• The Inter-Process Communication (IPC) has been redesigned to utilize shared memory. This redesign results in an amazing reduction in simulation runtimes. For example, a 20-second *SIMON* simulation with 0.02 second output intervals takes 38 seconds in Version 5.10 but only takes 8 seconds in 5.20. Additional examples are identified below:

Case/Event	5.10 Run Time	5.20 Run Time
EDSMAC4 Tutorial	13 sec	5 sec
EDVSM Tutorial L/R Tire Blowout	3 sec	1 sec
SimonDyMESHValidationSuite6 *EDSMAC4*, Test 11	57 sec	7 sec
SimonDyMESHValidationSuite6 *SIMON*, Test 12	8 min 10 sec	4 min 57 sec

• The Air Brake Tool in the *HVE-2D* Vehicle Editor now supports long stroke configurations for GBF users.

• Icons for connections are now displayed in the Vehicle Editor. Users can click on the oval for front or rear connection and display the Connections dialog for easy editing.

• The Event Controller layout has been modified to provide greater control when using the Frame Slider to rewind or advance simulation frames. The user first clicks on the extended frame slider to select it and then uses the thumb wheel on their mouse to advance frame by frame through the simulation.

• The Move CG dialog now includes an Apply button to allow the user to see results of changes before closing the dialog.

• Users can now copy and paste data into all tables (e.g., Collision Pulse). This will be especially helpful to users needing to import accelerometer or other experimental results directly into *HVE*.

• A *HVE* cube logo in the upper right corner spins during event execution as a visual cue to the user that calculations are being performed in the background

• The Tire-Terrain Radial Spring Sidewall Impact option now allows the user to select either one-sided or two-sided sidewall impact. This is useful for modeling tires rolling in ruts.

These are just a few of the enhancements in Version 5.20. Users are advised to read the Release Notes accompanying the update for specific details.

Important Note - *SIMON* Version 3.10

Users of *SIMON* need to be aware of several bug fixes that have been made since the release of *SIMON* 3.01 (*HVE* 5.10) that may change the results of their existing cases. These fixes are identified in the Release Notes for *SIMON* Version 3.10.

EDC's internal testing has revealed that the effects of these changes vary significantly from maneuver to maneuver, and that the magnitude of the effects is not predictable. EDC therefore recommends users to re-execute all existing *SIMON* events to determine the magnitude of the effect of these change on your individual events.

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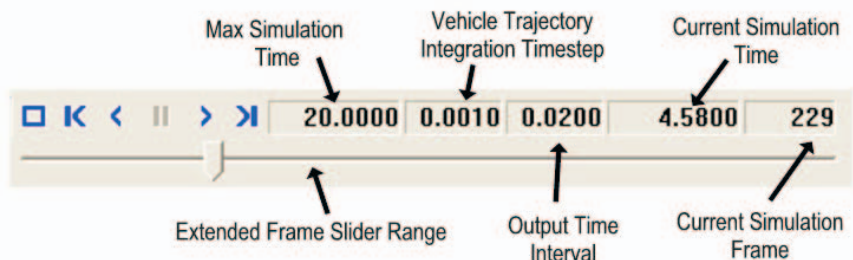
Technical Session

This Session provides an example of using the Tire-Terrain Sidewall Impact Model. The model has been significantly refined in *HVE* Version 5.20. The improvement is due to a change in `GetTerrainInfo()`. (As opposed to `GetSurfaceInfo()`, which is used by the Point Contact Tire-Terrain Model and seeks contact directly beneath the center of the tire, `GetTerrainInfo()` seeks contact in any specified direction, e.g., laterally through the tire sidewall.) Another major improvement is the addition of new logic which determines when radial and sidewall tire forces can exist simultaneously. A third important improvement is that impact with both the inner and outer tire sidewall may be modeled.

Model Description

The Sidewall Impact Model is an option available with the Radial Spring Model. The Radial Spring Model (see Figure 1) uses a set of springs that lie in the wheel plane and project radially outward from the wheel center to the tread surface. The Sidewall Impact Model assumes the tire sidewall may be modeled by a set of lateral springs (see Figure 2) having a linear force-displacement relationship. Each radial spring (again refer back to Figure 1) may have attached to it up to twelve lateral (sidewall) springs, six projecting towards the inner sidewall and six towards the outer sidewall (Figure 2 show eight sidewall springs).

Limitations

The assumption that the sidewall behaves in accordance with a linear force-displacement relationship imposes two important restrictions on the model. First, a broken rim is beyond the linear force-deflection assumption; rim breakage is not accounted for. (To correctly model rim breakage would require a non-linear stress analysis of the wheel rim, i.e., a finite element analysis.) Second, suspension deformation is not included. Thus, a high-speed curb impact that results in a total collapse of the suspension is not modeled directly by the sidewall impact model. However, a suspension failure may be approximated using the Wheel Damage Model, Displacement option.

Example

Our example uses a typical SUV and one of the environments that ships with *HVE*. We will perform two simulations, one at a low speed that trips the vehicle and one at a higher speed that also involves wheel displacement due to suspension collapse (see Limitations, above). We will use a step-by-step approach to allow users to follow along.
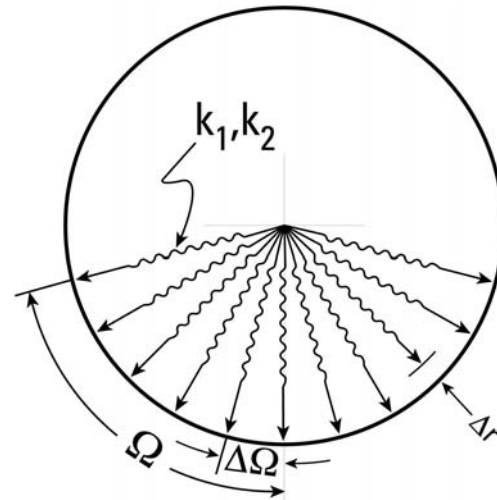

Figure 1 - Radial Spring Tire-Terrain Model, with progressive spring rates k_1 and k_2, angular span, Ω, angular spring spacing, $\Delta\Omega$, and radial adjustment increment, Δr.
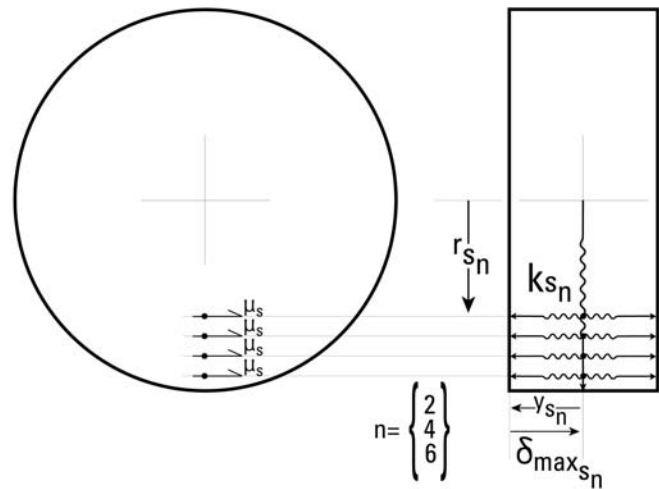

Figure 2 - Sidewall Impact Tire-Terrain Model option uses n sidewall springs located at r_{s_n} from the wheel center and sidewall spring constants, k_{s_n}

Perform the following steps:

1. Start *HVE*.

2. Add the *2002 Suzuki Vitara XL-7* (SUV) from the EDC vehicle database.

3. Add an environment and open the *EDVSMValidAASHTOCurb.h3d* geometry. This geometry includes a standard AASHTO curb at one end.

4. Add a *SIMON* event using the Suzuki. Name the event *20 MPH Curb-Tripped Rollover*.

5. Confirm that the *Show Key Results* and *AutoPosition* options are enabled.

6. Choose *Simulation Controls* and set the *Trajectory Timestep* to 0.001 sec. (choosing a small integration timestep is often required for simulating curb-tripped rollovers) and set the *Output Time Interval* to 0.01 sec.

7. Choose *Setup, Position/Velocity* and assign the initial position at *X* = 637.0 ft, *Y* = 154.0 ft, *Yaw* = -90.0 deg. (*Roll, Pitch* and *Z* are set by *AutoPosition* so the vehicle is initially resting on the ground). Set the *Sideslip* angle to 90 deg.

8. Choose *Setup, Wheels* and click the *Tire-Terrain* tab.

(a) Select *Axle 1, Right Side*. Select the *Radial Spring* model and click the *Sidewall Impact* option checkbox. Reduce the *Angular Span* to +/- 30 degrees from the default value, 90 degrees (this reduces by 2/3 the number of radial and sidewall springs, and, thus, reduces the execution time). Click on the *Spring Number* dropdown list and choose *Spring 4.* Then increase it's maximum deflection to 9.30 in. (this helps to prevent termination due to excessive sidewall deflection).

(b) Select *Axle 2, Right Side* and repeat step 8 (a), above.

9. Choose *Options, Get Surface Info* and select the *All Directions* option. This is necessary to ensure that the Sidewall Impact model sees the vertical curb surface. (By default, a simulation only looks at surfaces that are facing up, that is, surfaces that have a negative Z component. Computer rounding sometimes results in a perfectly vertical surface having a Z component of +0.0000001. Thus, this important surface may be ignored by the Sidewall Impact model.)

10. Execute the event. The first thing you will notice is how slowly it runs. The reason is that this environment has 1,126 polygons, and `GetTerrainInfo()` needs to search every one of these for every spring to determine the presence of sidewall contact with the curb. It makes sense to keep the environment as simple as possible when using the Sidewall Impact option.

11. Click *Select Variable* in the Key Results window. Choose the *Tires – Axle 1, Right, Outer* output group and select $F_{x,Sidewall}$, $F_{y,Sidewall}$, and $F_{z,Sidewall}$. Press *OK* to add these variables to the Key Results window. Continue to watch the simulation until it has run for about ½ second of simulation time.

Now, let's repeat the simulation, with two modifications: First, we'll increase the velocity to 35 mph and second, we'll add wheel displacement in an effort to simulate the effect of suspension failure.

Perform the following steps:

1. Choose *Copy*. Name the new event *35 MPH Curb-Tripped Rollover*.

2. Choose *Setup, Position/Velocity*, and change the *Total Velocity* to 35 mph.

3. Choose *Setup, Wheels,* click the *Damage* tab and choose *Axle 1, Right*. Click the *Is Damaged* checkbox and set the *Camber Change* to +35 degrees; set the *Start Time* to 0.015 sec and the *Duration* to 0.02 sec. Choose *Axle 2, Right,* Click the *Is Damaged* checkbox and set the *Camber Change* to +30 degrees, set the *Start Time* to 0.015 sec and the *Duration* to 0.02 sec.

4. Execute the run and observe the vehicle behavior.

Observations and Comments

Most curb-tripped rollovers probably result in some amount of suspension damage. In fact, the 20 mph event looks somewhat unrealistic (the vehicle bounces off of the curb) because of the rigid suspension. Accounting for suspension damage is an important part of the modeling process for curb-tripped rollovers.

The sidewall impact model is very sophisticated and robust. For example, the sidewall force calculations include the detailed effects of wheel steer and camber, as well as sidewall friction.

The new `GetTerrainInfo()` is significantly better at detecting sidewall vs. curb interaction than its predecessor in Version 5.10. However, as noted earlier, run times are significantly longer. Three things the user can do to help reduce runtimes are (1) keep the environment as simple as possible (i.e., limit the number of *Road* and *Friction Zone* polygons), (2) reduce the *Angular Span* from it's default value of 90 degrees to a smaller value. Remember, the *Angular Span* must be large enough to ensure that the sidewall springs make contact with the entire curb, and (3) do not click the *2 Sides* checkbox unless the inner sidewall contacts a curb.

The time required to simulate a curb-tripped rollover means it makes sense to break an event into two or more simulations. By isolating the curb-tripped portion as a separate event, you will be much more productive.

An interesting application for the model is the study of pavement edge drop-off. Preliminary investigations are very promising. However, a rigorous validation is currently lacking.
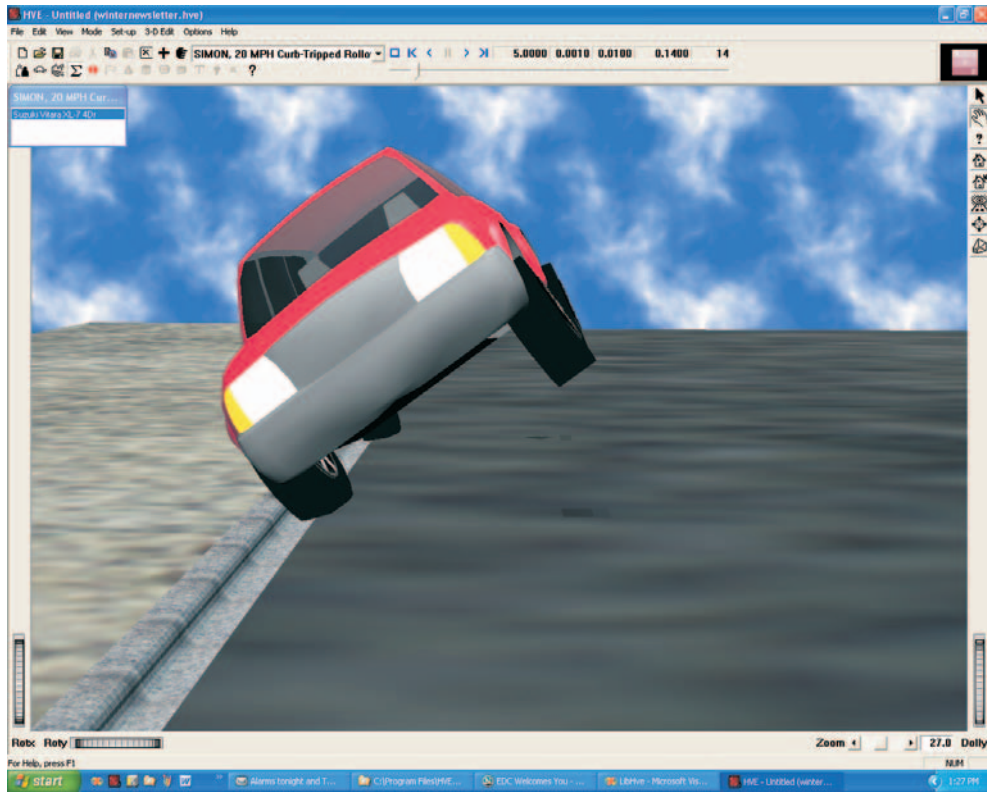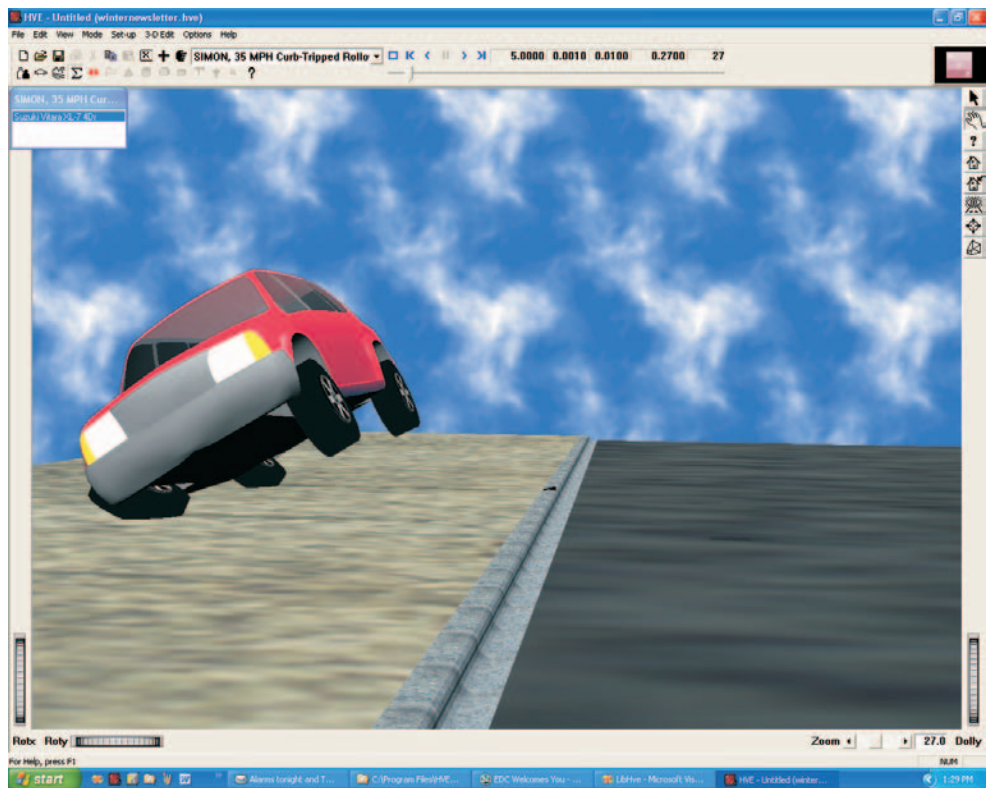
Figure 3 - 20 mph curb impact

Figure 4 - 35 mph curb impact

2007 *HVE* FORUM RECAP

The 2007 *HVE* Forum at the Hilton Palacio del Rio in San Antonio, Texas, was a great experience according to feedback from the attendees. Attendees were able to choose from workshops covering hands-on use of *HVE* and *HVE-2D*, building vehicles, building environments, discussions of physics models and vehicle dynamics.   The workshops, Users Group, presentations and social hours were of great benefit to all users, no matter what level of experience they had before. Here are some of the highlights of the week's activities:

Who Wants To Be A *HVE* Jillionaire

The Monday Night Social Hour once again tested users in the "Who Wants To Be A *HVE* Jillionaire" game. Three contestants answered all seven multiple-choice questions correctly to win 500 Bronco Bucks, good towards $500 of EDC products or services. (It seems that every contestant who plays becomes a Jillionaire winner. . . maybe your name should be in the drawing next year!)

Advanced *HVE* Workshops

In the previous two years of Advanced *HVE* Workshops, several separate scenarios were used to discuss a variety of problem solving approaches. This year, one all-encompassing case study was developed to provide a thorough methodical approach to applying the physics models in the analysis of a real-world scenario. The scenario was a tractor-trailer traveling along on a city street. A SUV pulls out immediately in front of the tractor-trailer, causing the truck driver to apply the brakes resulting in the jack-knife of his

vehicle. While the tractor-trailer is sliding along in the jack-knife, there is an impact with the side of the SUV. The SUV separates sliding sideways and then hits a curb and overturns into a median. Whew!

The attendees then used a combination of *EDCRASH*, *EDSMAC4*, *SIMON* (including *DyMESH* and the Tire-Terrain models, GBF, ReadDataFile and a few other utilities to study   the effect of truck brake adjustments, determination of impact speeds, speed change during collision and also the rollover dynamics. Attendees also used the Playback Window to chain together the series of events leading to crash.

This single case study approach for the Advanced *HVE* workshops was well received by the attendees and has been requested for the Advanced *HVE* workshops at the 2008 *HVE* Forum.

Terry Day, President of EDC, welcoming the attendees to the 2007 *HVE* Forum during the Opening Remarks presentation celebrating 25 years of EDC.

HVE Jillionaires James Lock, Graham England and Toby Frerich are flanked by Jillionaire Host Wes Grimes (left) and Terry Day.

2007 Users Wish Lists

In previous years, only the Top Ten features or improvements Users would like to see added to *HVE* or *HVE-2D* were submitted on the Wish List. This year, Users submitted their entire list as follows:

HVE Users Wish List

- On the Connections dialog, display the height of the connection relative to the ground

- On Surface Editor dialog in 3-D Editor when using Vertex Edit. Display the entire data field, so when you highlight to change the value you get all of it.

- When you copy an event, also copy the Key Results selection settings.

- Improve the aerodynamic load modeling in *SIMON*

- When tabbing through a dialog (like Simulation Controls) make it stop only on data entry fields

- Allow global camera views to be assigned for all Editors/Viewers and also have preassigned views such as Damaged Vehicle - Plan View, etc.

- Enter parameters in a table format - in Vehicle Editor, in Event Set-up for truck brakes, etc.

- Allow trailer-truck contact during jack-knife to limit articulation angle rather than terminating event due to excessive articulation angle.

- Allow for a file name to be entered when saving a vehicle, rather than only direct to user.db.

- In the Vehicle Editor, allow the user to copy tires / brakes / anything to the rest of the vehicle, instead of just to the other side of the axle.

- In the Damage Profiles dialog in an *EDCRASH* event, show all damage zones for crush measurement entry rather than having to use the slider.

- Open Output Reports larger to display all information on a page rather than having to manually resize.

- Be able to generate a list of vehicles contained in all *.db files.

- In 3-D Editor, select all objects by overlay (layer) name, then toggle through all objects using arrow keys (objects individually highlighted)

- UNDO last command

- Allow the user to enable/disable ABS in the Event Editor for a vehicle fitted with ABS

- Make transitions between events easier (inherit event data).....load key data, etc.

- Provide access to Variable Output Mesh Data and Sidewall Springs data. (Vehicle mesh tools - show damaged vertices, distance moved, etc.)

- Ability to change order of columns in VariableOutput.

- Option for Pathfollower to follow a line in the environment - Maybe a table entry of up to 100 nodes.

- In the Damage Profile output report, display a measurement grid and also a ghost image of the undamaged vehicle to allow for visual evaluation of crush damage

- Allow the export of the vehicle damaged mesh geometry

- In Playback Window, allow the user put a "hold" at the start or at the end of the recorded AVI file.

- In the Vehicle Data report, flag values that are default or measured data and identify the source.

- Allow the user to add or remove a vehicle to/from an existing event

HVE-2D Users Wish List

- Create *EDSMAC4* event from *EDCRASH* output.

- Create help topic for CDC entries.

- Enable multiple item selection in Report Type (Playback Editor).

- Vehicle images in database available online.

- Tire path traced in event. Enable color selection. (Center of mass path, too)

- Enable colored display of skidmarks.

- Enable skidmark display by vehicle (show or hide).

- Position descriptions context sensitive to calculation method, plus more available positions.

- Closed loop *EDSMAC4* simulation model (optimization). Report certainty.

- Display the coordinates of the current location of the cursor in the Event Editor.

- Increase impact to rest positions in *EDCRASH* included in separation velocity calculations.

- Recall folder from last saved file.

- Enable preferences to permit opening last file.

- Provide documentation for vehicle data in *EDVDB*.

- Enter all vehicle dimensions in one dialog.

2008 *HVE* Forum - San Diego, CA

During the Users Group, the winning votes on where to hold the 2008 *HVE* Forum were for San Diego, California. The exact location and dates will be announced on the EDC website as soon as they have been confirmed. Workshop schedules, descriptions and registration forms will be available to download later this summer. See you in San Diego in 2008!

DiscoverHVE.com

On April 1, 2007, Collision Engineering Associates will launch a new website where subscribers can learn more about using *HVE* by viewing basic, intermediate and advanced video tutorials. They can also participate in on-line discussion groups covering various topics such as tire side-wall impacts, video output, importing vehicles and scenes, using humans in *HVE*, and known issues or work-arounds. Visit www.DiscoverHVE.com or contact Collision Engineering Associates at 480-655-0399 for special introductory offers.

HVE and *HVE-2D* F.A.Q.

This section contains answers to frequently asked questions submitted to EDC Technical Support staff by *HVE* and *HVE-2D* users.

Q. I'm trying to simulate a collision involving a sedan impacting with the front axle of a heavy truck. I'm using SIMON and DyMESH and I believe I have set up my event properly. However, when I run the simulation, I see that the front of the sedan passes through the tire/wheel and doesn't begin interacting with the truck until it reaches the wheel well. Why?

A. *DyMESH* uses the vertices/surfaces described by the vehicle geometry file for collision modeling. A tire/wheel is an object that is visualized by *HVE* so that it can be shown rolling, turning, displacing, etc. during a simulation. The tire/wheel vertices/surfaces are not contained in the vehicle geometry file, therefore a vehicle body will not interact with a tire/wheel in a *DyMESH* collision simulation. If your sedan was impacting with the passenger door of the truck, then you would immediately see the collision interaction. But when you are impacting with a tire/wheel, your sedan will continue until it contacts a surface of the truck, in this case the face of the wheel well.

Q: I just loaded HVE Version 5.20 and re-executed a SIMON/DyMESH event I had previously created. When I view the Program Data report it shows I used DyMESH Version 0.90, but my license shows that I am using Version 1.20, which is the version of DyMESH corresponding to HVE Version 5.20. Why doesn't the Program Data report say Version 1.20?

A: The Program Data report is displaying the version of *DyMESH* that was used when the event was originally created. The reported version number will be updated to the current correct version number if the user returns to the event, selects *Options, DyMESH* and then clicks OK on the *DyMESH* Options dialog.

Q. I'm using the 3-D Editor to assign the Friction Factor and Type to various surfaces in my environment model. I noticed that the Object Attributes dialog has a Material Edit button that allows me to view and edit the Environment Material Properties for my selected surfaces. What values should I be adjusting in this dialog?

A. The values you adjust in this dialog all depend on which physics models you are using in your simulations. For example, if you are using *EDSMAC4*, then only the Friction Factor value would be used in the calculations. However that value was already available for you to edit directly in the Object Attributes dialog so you would not have been required to enter the Material Properties dialog. Almost all of the physics models do not require the user to enter the Material Properties dialog.

If you are using *SIMON* and the Soft Soil Tire-Terrain option, then you might consider adjusting several of the soil properties shown in the dialog. In fact, the Soft Soil Tire-Terrain option would be the only physics modeling to use the parameters shown on this dialog (at the time of writing of this column). For more details about the Soft Soil Tire-Terrain Model, refer to the Technical Session of the Summer 2006 Technical Newsletter.

Q: I am trying to create a single vehicle event using EDSVS as my calculation method. In the Event Editor I clicked on the + button to add the event. When the Event Information dialog appeared, I noticed that my single vehicle was already selected and displayed in the Event Vehicles list on the dialog. I only had to select EDSVS and click the OK button. However, when I click the OK button to create the event, I receive an error message saying "Incompatible Objects: wrong number of objects". EDSVS is a single vehicle simulation model and I have only a single vehicle selected, so why am I being told that I have the wrong number of objects?

A: This situation can occur randomly on some computers. We have not identified a configuration or other key factors. What we do know is that the issue is when you are adding the event, you will see that the only vehicle in the Vehicles list is automatically listed in the Event Vehicles list of the Event Information dialog. When you click OK, your computer for some reason doesn't "hand" that vehicle in the Event Vehicles list to physics, so physics thinks that you do not have any vehicles and it issues the error message. If you get this message, simply try to add the event again, but this time unselect and reselect the vehicle from the Vehicle List to refresh the Event Vehicles list and then click the OK button. You will find that you now can create the event and continue working as expected.

EDC Training Courses

EDC Reconstruction & EDC Simulations

EDC offers an excellent training course on the use of the EDC reconstruction program, *EDCRASH*. Both new and long-time users of *EDCRASH* agree that the *EDC Reconstruction* course is extremely beneficial and challenging.

EDC also offers an excellent training course on the use of EDC simulation programs, such as *EDSMAC*, *EDSMAC4*, *EDSVS* and *EDVTS*. The *EDC Simulations* course offers the fastest way to learn what you really need to know – how to efficiently use the program and get the right results.

These one-week courses are designed to fully investigate the program's inner workings. Lectures are full of helpful hints gained from years of experience. During the course, students will use the programs (e.g. *EDCRASH*, *EDSMAC4*) in either the *HVE* or *HVE-2D* simulation environment to complete several workshops highlighting the capabilities of the programs.

HVE Forum

The *HVE* Forum is an excellent opportunity for *HVE* and *HVE-2D* users to jump to a new level of ability. By participating in workshops, attendees brush up on their present skills, learn new techniques, and learn how to use the latest advancements in the software. The *HVE* Forum also presents a great opportunity to meet other users and expand your network of resources.

Engineering Dynamics Corporation
Training Course Schedule

EDC Simulations

Los Angeles, CA . . . . January 2009

Miami, FL . . . . November 12 - 16, 2007

EDC Reconstruction

Los Angeles, CA . . . . January 2008

Miami, FL . . . . November 2008

Theoretical & Applied Vehicle Dynamics

TBD. . . . . TBA 2007

2008 *HVE* FORUM

San Diego, CA . . . . February - March 2008

Vehicle Dynamics

Theoretical and Applied Vehicle Dynamics extends the theory of the basic SAE course and includes direct applications using several vehicle simulation programs (e.g. *SIMON*, *EDVSM*) within the *HVE* simulation environment, as well as a solid theoretical background for such simulations. The course is focused towards vehicle design engineers and safety researchers with an interest in a greater understanding of vehicle dynamics and automotive chassis systems development.

Hands-on Training

Intensive hands-on training on how to use your *HVE* or *HVE-2D* system software, physics programs and databases is available. Contact EDC Customer Service for more information about bringing this two-day on-site course to your office.

Course Registration

You may register for a course by contacting EDC Customer Service at 503.644.4500, or by email to training@edccorp.com. You can also visit the Training pages on our website and download a course registration form. All courses are eligible for Continuing Education Units and ACTAR credits. See you at our next course!

Related Training Courses

Northwestern University Center for Public Safety (NUCPS) is no longer actively scheduling the COMPTAR and MATAR courses which used *EDCRASH* and *EDSMAC*. The material previously covered in these courses is covered in the EDC Reconstruction and EDC Simulations courses. If you are interested in hosting one of these courses at your location, please contact EDC Customer Service at 503.644.4500.