

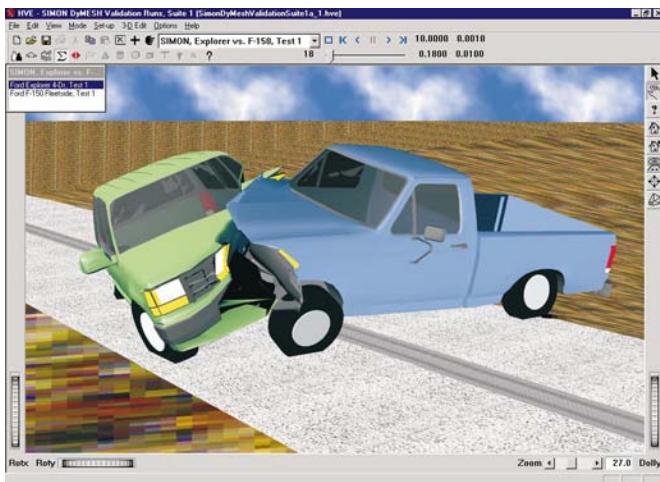
Technical Newsletter

HVE & HVE-2D Version 5 Now Available

HVE and *HVE-2D* Version 5.0 were released on April 5, 2004. This highly anticipated release delivered numerous enhancements, improvements and new capabilities to users.

Highlights of Version 5.0

- *DyMESH* - *HVE* users will now be able to use *DyMESH* in conjunction with the *SIMON* vehicle dynamic simulation model to study complex real-world crashes involving 3-dimensional collision dynamics.



Example screenshot of a *SIMON* simulation using *DyMESH* to study the crash of a Ford F150 pickup into a Ford Explorer.

- Tessellation - Tessellation allows the user to add additional detail to the 3-D Geometry File of a vehicle when used in collision simulations in *DyMESH* or *EDSMAC4*.
- Active Objects List in Playback - Users can quickly access open reports and viewers in Playback Mode by selecting from the Active Reports list located in the center of the Toolbar.
- Print All - Users can select *File, Print All* to print all open reports and viewers displayed in Playback Mode.

- Multiple Cameras - Users can assign and save up to 10 named cameras in their simulations.
- View From, Look At - *HVE* users can assign the camera view to track a moving object, even if the camera is attached to a different moving object.
- Wheel Images - Photographs or drawings of actual or generic wheels images are now automatically applied to and displayed on vehicles in *HVE*.
- Easy Access to License Information - The Technical Support dialog now displays information to help users easily troubleshoot any licensing problems.

New Vehicles Added To The Database

The following vehicles have been added to the *EDVDB* vehicle database:

Vehicle	Year Range
Cadillac Coupe de Ville	1977-1984
Ford Focus SE 4-Door	2000-2004
GMC Sierra 1500	1999-2004
Chevrolet Silverado 1500	1999-2004
Toyota Camry LE 4-Door	2002-2004
Subaru Legacy Outback Wagon	2002-2004
Toyota Corolla LE 4-Door	2003-2004
Land Rover Discovery	1995-1998
Pontiac Grand Am 4-Door	1992-1998
Toyota 4-Runner	2000-2002
Chevrolet Tahoe	2000-2004
GMC Yukon	2000-2004

Updates For Supported Users

Version 5.0 updates have been shipped to all users with current Update/Technical Support policies. These updates included the Version 5.0 CD, a new license file and updated User's Manual. User's are encouraged to install their updates and begin taking advantage of the new features and enhancements as soon as possible.

Technical Session

This Technical Session describes a powerful feature that is under-utilized: the Event Set-up, Wheels dialog. This dialog has three tabbed pages:

- Tire Blow-out page
- Wheel Damage page
- Wheel Brake page

Each of these pages contains important parameters, especially for vehicles involved in a collision. Their use is described below.

Tire Blow-out

The *HVE* Tire Blow-out Model™ is used for modeling the effects of a tire blow-out (loss of air) during a simulation. The Tire Blow-out Model is a powerful feature, and it's easy to use. The parameters used by the Tire Blow-out Model are:

T_{start} – Time when the blow-out begins (using the AutoStart checkbox causes the blow-out to triggered automatically by some event – such as a collision)

T_{duration} – The time interval over which the deflation occurs. This is normally 0.10 second, although the user may make it as short or as long as desired.

Stiffness Factor – The fraction of the tire's original cornering stiffness and radial stiffness remaining after the blow-out is complete. This is normally 10 percent of the original stiffness.

Rolling Resistance Factor – The increase in the tire's original rolling resistance after the blow-out is complete. This is normally an increase of 10 times the original value.

The *HVE* Tire Blow-out Model page is shown in Figure 1.

The method employed by the Tire Blow-out Model has been described previously and validated [1]. Briefly, the model uses linear interpolation to vary the tire's radial stiffness, cornering stiffness and rolling resistance from their original values to their modified values over the time interval defined by T_{start} and $T_{duration}$. The Tire Blow-out Model may be applied to any or all tires on a vehicle, including individual (inner and/or outer) dual tires. The model provides exceptionally detailed transient information (tire forces, sprung mass roll, pitch and yaw, etc) occurring during and following a tire air loss.

[1] Day, T.D., Grimes, W.D., Blythe, W., "3-Dimensional Simulation of Vehicle Response to Blow-outs," SAE Paper No. 980221.

The *HVE* Tire Blow-out Model should be used for all events involving a reduction in tire air pressure. Examples include handling simulations involving blow-outs on straight or curved paths, as well as events involving collision-related tire debanding. The *HVE* Tire Blow-out Model has also been used successfully for studying tread separation.

The *HVE* Tire Blow-out Model is implemented for *SIMON* and *EDVSM*. A limited, 2-dimensional version is implemented for *EDSMAC4*.

Wheel Damage

The Wheel Damage option improves the modeling of vehicles with wheels damaged by collision. The parameters used by the Wheel Damage option are:

T_{start} – Time when the wheel damage begins (using the AutoStart checkbox causes the damage to triggered automatically by some event – such as a collision).

T_{duration} – The time interval over which the damage occurs. This is normally 0.10 second, although the user may make it as short or as long as desired.

Peak Lock-up Torque – The percentage of braking torque required to lock the wheel on flat terrain under static load. The default value is 100 percent; this may be decreased as required to simulate partial lock-up, or increased as required to ensure lock-up under higher friction or loading conditions.

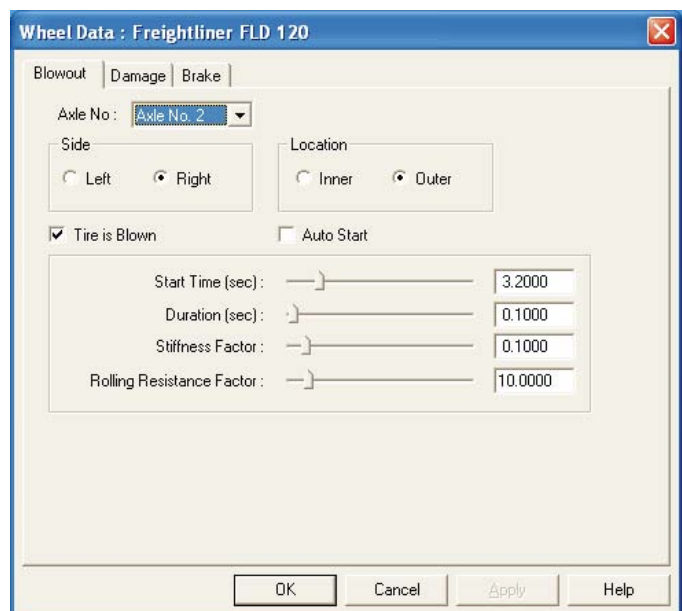


Figure 1 - Event Set-up, Wheels dialog, Tire Blow-out page

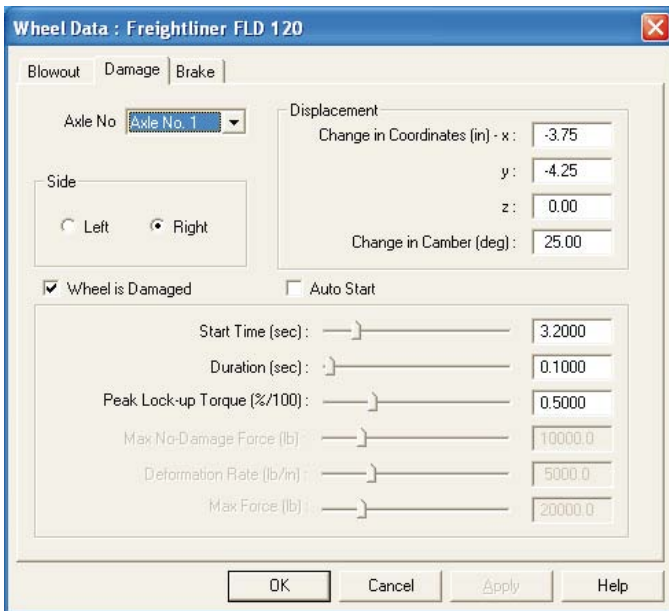


Figure 2 - Event Set-up, Wheels dialog, Damage page

Displacement – The change in vehicle-fixed wheel x,y,z coordinates and camber angle.

The Wheel Damage page is shown in Figure 2.

The Wheel Damage option uses linear interpolation to displace the wheel and/or increase the current level of wheel torque to the peak value over the time interval

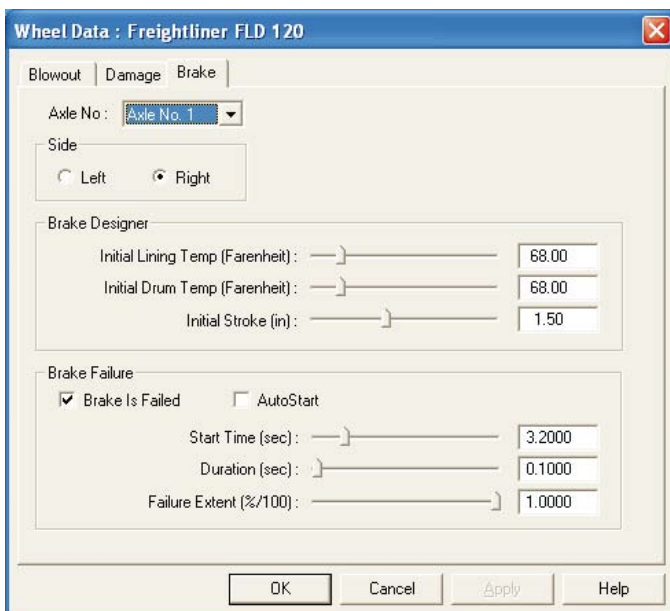


Figure 3 - Event Set-up, Wheels dialog, Brake page

defined by T_{start} and $T_{duration}$. The Wheel Damage option may be applied to any or all wheel locations on a vehicle. When used with the *SIMON* vehicle dynamics model, the Wheel Damage option allows the user to study locked wheels while maintaining the use of the wheel spin equations of motion (use of the Percent Available Friction brake table option clobbers these equations of motion; thus it is not recommended for *SIMON*). *SIMON* uses the current wheel displacements to correctly distribute the vertical tire force, F_z , for wheels that have been displaced during a collision. Because the distance from the CG to the tire contact patch affects the yaw moment acting on a spinning vehicle, the post-impact path may be significantly influenced by displaced wheels.

The Wheel Damage option should be used for all events involving a collision-induced wheel lock-up or displacement. The Wheel Damage option is supported by *SIMON*. A 2-dimensional version is implemented for *EDSMAC4*.

Wheel Brake

The Wheel Brake option has two components:

- Brake Designer
- Brake Failure

The parameters included in the Brake Designer component are:

Initial Pad/Lining Temperature – The temperature of the friction material (pad or lining) at the start of the simulation.

Initial Rotor/Drum Temperature – The temperature of the brake rotor or drum at the start of the simulation.

Initial Brake Stroke – For S-cam air brake systems, the stroke at the start of the brake application required to produce brake torque.

The Wheel Brake page is shown in Figure 3.

The Brake Designer option uses a thermodynamic model to compute the internal temperature of the brake lining and drum at 13 locations. These temperatures increase or decrease as braking heat energy is added by brake torque and removed by conduction and convection. These changes in temperature affect the current coefficient of friction of the lining material, as well as the stroke required in an S-cam brake to apply brake torque. The Brake Designer option may be applied to any or all wheel locations on a vehicle.

The Brake Designer option should be used for all events involving prolonged brake application where

brake failure at one or more brakes is suspected due to excessive temperature and/or poorly adjusted slack adjusters. The Wheel Brake option is supported by *SIMON* and *EDVDS*. *EDVSM* also uses the Brake Temperature model, but does not include the Brake Stroke portion of the model.

The Brake Failure option is new for *HVE* Version 5. The parameters included in the Brake Failure component are:

T_{start} – Time when the brake failure begins (using the AutoStart checkbox causes the damage to triggered automatically by some event – such as a collision).

T_{duration} – The time interval over which the failure occurs. This is normally 0.10 second, although the user may make it as short or as long as desired.

Failure Extent – The fraction of normal brake torque resulting from failure. The default value is 100 percent (i.e., total brake failure); the percentage may be decreased as required to model partial brake failure.

The Brake Failure option uses linear interpolation to reduce the current level of wheel torque to the specified fraction of normal brake torque over the time interval defined by **T_{start}** and **T_{duration}**. The Brake Failure option allows the user to study the effects of sudden or gradual brake failure at an individual wheel. The Brake Failure option may be applied to any or all wheel locations on a vehicle. Note that this option is different from the temperature-related brake failure described in the previous section.

The Brake Failure option should be used for all events involving a sudden brake failure at one or more wheels. The Brake Failure option is supported by *SIMON*, *EDVSM* and *EDVDS*.

We opened the Technical Session by saying these options are under-utilized. This is true. Reflecting on each of these features, one realizes how often issues, such as blow-outs, wheel displacements, partial or total wheel lock-up and brake failure occur during real-world crashes. The Event Set-up, Wheel options accurately model these conditions - and they are easy to incorporate into your simulations. We encourage users to use them.

A compilation of Technical Sessions, F.A.Q.'s and Tips & Techniques sections from previous newsletters is available:

EDC Library Publication 1080 - US\$ 45.00

A San Francisco Treat

2004

HVE FORUM

Workshops

- Hands-on Workshops Using EDCRASH, EDSMAC, EDSMAC4, EDSYS & EDVTS
- Creating Lighted and Textured Environments Using the HVE 3-D Editor
- Advanced Case Studies Using SIMON, EDVSM, EDVDS & EDSMAC4
- Multi-Occupant Human Impact Simulation Using GATB
- Importing Scene Drawings as Environment Models
- Advanced Multi-vehicle Simulation Using SIMON
- DyMESH 3-D Collision Simulation Applications
- Importing 3-D Environments from Total Stations
- Developing HVE-compatible Physics Models
- DyMESH 3-D Collision Algorithm Overview
- Theoretical and Applied Vehicle Dynamics
- Multi-Vehicle Collisions Using EDSMAC4
- Tractor-Trailer Simulation Using EDVDS
- Simulating Blow-outs and Rollovers
- Building Vehicles for HVE/HVE-2D
- Recording 3-D Simulation Movies
- HVE and HVE-2D User's Groups
- Powerful Tips and Techniques
- Navigating in HVE/HVE-2D
- Brake System Simulation
- HVE White Paper Session
- ABS Simulation
- Animation

May 3 - 7, 2004
Crowne Plaza
Union Square
San Francisco, CA

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2004 HVE FORUM

The 2004 *HVE* Forum will be in San Francisco at the Crowne Plaza Union Square from May 3 - 7, 2004. The 2004 *HVE* Forum will include workshops on the use of *HVE* and *HVE-2D*, the physics programs, *HVE* Brake Designer, and *DyMESH*. It will also include the *HVE* White Paper Session, the *HVE* Jillionaire Game and the *HVE* Simulations Festival.

Workshops and hotel rooms are on a first-come, first-served basis, so be sure to register in advance to ensure you get the choices you want. Additional information, workshop schedules and registration forms are available to download on the EDC website www.edccorp.com/service/hveforum.html. If you have not already registered to attend, there is still time to sign up, make your travel arrangements and join your colleagues at the 2004 *HVE* Forum.

SEE YOU IN SAN FRANCISCO!

2004 HVE Forum Site Feature of Three Perfect Days Section in Hemispheres Magazine

If you haven't already decided how to spend your free time in San Francisco before or after the 2004 HVE Forum, then reading this article may leave you with some great ideas. The *Three Perfect Days* feature in the April 2004 issue of United Airlines *Hemispheres* magazine points out some of the visual and performing arts, shopping, dining and sight-seeing highlights of San Francisco. Several of the locations mentioned in the article are right in Union Square, very near to the Crowne Plaza Union Square hotel.

If you fly United this month, then a copy of the article can be found in the magazine in the seat pocket in front of you. If you don't fly United this month, then you can still read the same article on the internet by visiting the *Hemispheres* magazine website, conveniently located at www.hemispheresmagazine.com. Just follow the link to the *Three Perfect Days* feature. You'll also find a map of the locations mentioned in the article. Enjoy!

SIMON and DyMESH Validation Paper Presented at 2004 SAE World Congress

Engineering Dynamics Corporation is pleased to announce the publication of an important technical paper titled "Validation of the SIMON Model for Vehicle Handling and Collision Simulation – Comparison of Results with Experiments and Other Models." This paper was presented on Thursday, March 11, 2004, during the Accident Reconstruction sessions of the SAE 2004 World Congress.

Copies may be obtained by contacting EDC Customer Service, or by downloading directly from the Technical Reference Library of the EDC website at www.edccorp.com/library/techref.html. The paper is SAE 2004-01-1207, EDC Library Document No. 0034.

Additional technical papers which have been authored by HVE users regarding the application of SIMON can be found in the HVE White Papers section of the Library.

Easy Access to License Information in Version 5

The new Technical Support dialog in Version 5 provides the user with helpful information to troubleshoot any problems with the licensing of their programs. The dialog now displays the version number for the system software and for each of the licensed physics programs. The dialog also displays the hardware system codes for the computer's hard disk, the EDKEY and the license file. The dialog includes options to allow the user to copy this information to the system clipboard (for pasting into an email) and to print a hard copy (for faxing). This feature greatly simplifies the task of confirming that the EDKEY and HVE license information are compatible.

EDC Technical Support

To Contact EDC Technical Support

Phone : 1.503.644.4500
 Fax : 1.503.526.0905
 Email : support@edccorp.com

Please Provide Your

Name : John Doe
 Company : Doe Engineering Services
 User ID : 9999-1

Your System Software Information

HVE Version : HVE 2-D Version 4.50

Your System Codes

Hard Drive : 0x232EF
 EDKEY : 0x27EF0
 License : 4-232EF

Your License File Information

Option	Version
HVE2D	4.50
EDCDB	4.50
EDCRASH	7.20
EDSMAC	4.10
EDSMAC4	6.20
EDSVS	7.20
EDVTS	7.20
EDGEN	2.40

OK Clipboard Print

Importing Vehicle Geometries into HVE

If a specific make and model of vehicle is not available from the *EDVDB* vehicle database, a user can order a custom vehicle from EDC or choose to build the vehicle on their own. Users who build their own vehicles may follow procedures outlined in White Paper WP-2006, "Building Vehicles for *HVE*", or in the "Building Vehicles For *HVE* & *HVE-2D*" workshop at the *HVE* Forum.

These procedures include tips on using a digitizer to create the vehicle geometry file. In some cases however, a user may choose not to create their own geometry for the vehicle, but rather purchase one from 3D model suppliers or download one from modeling community websites. Experienced CAD users manipulate the vehicle geometry files obtained from websites or suppliers to match the scale and orientation requirements of *HVE*. An important step however, is importing the geometry into the Vehicle Editor. If the file is of type VRML (.wrl), the file may be brought directly into the Vehicle Editor. If the file is of type DXF, then a series of steps must be followed to translate and then import the file.

Here is a summary of the process using the Environment Editor DXF translator to convert the file from DXF to an Inventor (.iv) format model than can be directly imported into the Vehicle Editor:

1. Go to the Environment Editor and click on the Add New Object button to add an environment. In the Environment Information dialog, choose to open a geometry file. In the file browser for the geometries, change it to display *Files of type DXF Files* and then locate and select the DXF file of the vehicle model.
2. When the vehicle geometry appears in the Environment Editor, the geometry has been converted from DXF to a *HVE*-compatible format. Do not try to save this geometry as an environment model. The temporary file created by the translator is used instead.
3. Using a file browser outside of *HVE*, locate the file named temp.iv in the *HVE* folder. This is the temporary file created by the translator. Rename this file to be appropriate for the vehicle. Move this file to the supportFiles/images/vehicles folder.
4. Start a new *HVE* case or open the case that has the vehicle requiring the geometry. Once the vehicle is displayed in the Vehicle Editor, click on the CG, select Geometry File, change to Files of type .iv and then select the file. The vehicle geometry file will now be displayed on the vehicle.

Matching the Connections Between Vehicles

When a user creates an *EDSMAC4* or *EDVTS* event, the compatibility of the connections (see Table 1) and their relative heights is checked by *EDSMAC4*. If either of these conditions is not satisfied, an error message is displayed informing the user of the problem. The most frequently encountered error message is about the connection heights. The vertical height of the connections between the tow and towed vehicles must be within a distance of 1 inch (2.54 cm) of each other relative to the ground.

Here is a series of steps to help users properly adjust the connection heights of the vehicles before trying to create an event:

1. Display the tow vehicle in the Vehicle Editor. Click on the CG and select Move CG on the pop-up menu. Note the value for CG height displayed at the bottom of the dialog. Close the dialog.
2. Click on the tow vehicle's CG again and select Connections on the pop-up menu. Note the value for the z coordinate for the rear connection. Remember that a negative z coordinate for the connection physically places the connection above the CG of the vehicle because of the SAE coordinate system.
3. Subtract the connection z coordinate from the CG height of the vehicle. (BE CAREFUL! Subtracting a negative number is the same as adding a positive number.) The resulting value is the connection height above the ground for the tow vehicle.
4. Repeat the above steps for the trailer (or towed vehicle) to determine the connection height relative to the ground for the front connection of the trailer.
5. Edit the connection z coordinate of the vehicle(s) to bring them into within 1 inch (2.54 cm) of each other.

Repeat this process for each set of connected vehicles involved in the event. A table of connection compatibility between the vehicles is provided below.

Table 1 - Compatible connections between the tow vehicle and towed vehicle

Tow Vehicle Rear Connection	Towed Vehicle Front Connection
Ball	Hitch
Fifth Wheel	King Pin
Pintle Hook	Fixed Drawbar
Pintle Hook	Hinged Drawbar

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

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

Q: I have set up an EDSMAC4 simulation involving a truck with unloaded generic class 4 trailer combination with hard braking. I have set the % available friction value to 1.0 for all axles of the truck and the trailer. I am only seeing skidmarks from the truck and not the trailer. Why?

A: The vertical force (load) on the tires of the trailer is less than the value assigned for the Min FZ for skidmark setting in the tire dialog in the Vehicle Editor. In *HVE-2D* this value is set in the Tire Information dialog. In *HVE*, this value is set in the Tire Physical Properties dialog.

To determine if this is the cause, add the value for Fz' for each tire on the axles of the trailer to your Key Results Windows and see if the values are less than the value set for Min Fz. If so, then you can adjust the value for Min Fz to be less than the vertical tire forces experienced during the simulation.

Q: I am reviewing the work of another reconstructionist who is using HVE or HVE-2D. What information do I need to request from that expert in order to evaluate his or her results?

A: For both *HVE* and *HVE-2D*, you should request the case file (with the events executed).

The case file will contain all environment (including the 3-D geometry) and vehicle data. The case file does not contain any 3-D vehicle geometry files. These files are required for reproducing *DyMESH* simulations involving collisions and *EDVSM* simulations involving rollover. These 3-D geometry files are licensed property and cannot be transferred without permission of the vendor (EDC, Digimation or whomever). These files may however, be purchased from the vendor.

Q: What is the source for the tire data found in the Vehicle Editor?

A: All default tire data in the *HVE* Vehicle Database is based on results from experimental studies performed by Calspan, UMTRI or EDC. The majority of data for passenger vehicle tires is derived from tests performed by Calspan Corporation in 1983 (Extended Tire Testing: Tapia, G.A.; Report number 6871-V-1, Nov. 1983 - available as EDC Library Reference 1092).

These tires were tested on Calspan's flat-bed tire test machine. The majority of data for heavy truck tires is derived from tests performed at the University of Michigan in 1981 [unpublished data; University of Michigan Transportation Research Institute, 1981]. These tires were tested on UMTRI's flat bed tire test machine. Tire data for tires that were not tested by either Calspan or UMTRI are found by interpolating between actual test data.

There is very little tire data available from 1983 to 1999. However, in 1999 EDC conducted a comprehensive test program of 21 common tires at the Calspan tire test facilities. This data is available for purchase by contacting EDC Customer Service.

F.A.Q.'s on EDC Website

The EDC website provides a special section dedicated to Technical Support, including answers to F.A.Q.'s from this and previous Newsletters. We encourage you to visit this page to search for answers to your questions before contacting Technical Support for assistance. Go to www.edccorp.com and follow the link to Support.

User Hints and Tips

This section contains useful hints and tips to help *HVE* and *HVE-2D* users make the most of their software.

- When positioning vehicles in *EDCRASH*, remember that heading angles of 200° and -160° are different. *EDCRASH* uses these angles to determine direction of rotation by subtracting the final/rest heading from the impact heading. If the result is positive, the vehicle rotated clockwise. Likewise, if negative, the vehicle rotated counterclockwise.
- When importing DXF format environment models, use the Options button on the Environment Information dialog to "Flip about the X-axis" or "Scale" the model during the import. This will allow you to import the original AutoCAD DXF file and rotate and resize it directly in *HVE*, rather than having to mirror and rotate and flip and scale in AutoCAD before exporting as a DXF. This saves considerable time and effort!
- *HVE* and *HVE-2D* offer many capabilities that users may overlook or not take complete advantage of for their cases. If you want to discover these capabilities and how they can best be applied to your regular routine, then sign up to attend the 2004 *HVE* Forum today!

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 2005
Miami, FL November 2005

EDC Reconstruction

Los Angeles, CA January 2006
Miami, FL November 8 - 12, 2004

Theoretical & Applied Vehicle Dynamics

San Francisco, CA (short course). May 3 - 4, 2004

2004 HVE FORUM

San Francisco, CA May 3 - 7, 2004

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 and ACTAR credits. See you at our next course!

Related Training Courses

Northwestern University Center for Public Safety (NUCPS) is offering the COMPTAR and MATAR courses once again. These courses are designed to provide law enforcement officers with a better understanding of using *EDCRASH* and *EDSMAC* for accident reconstruction. For more information or to register for these courses, you will need to visit the NUCPS website at www.northwestern.edu/nucps or by contacting the NUCPS office at 847-491-5476.

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