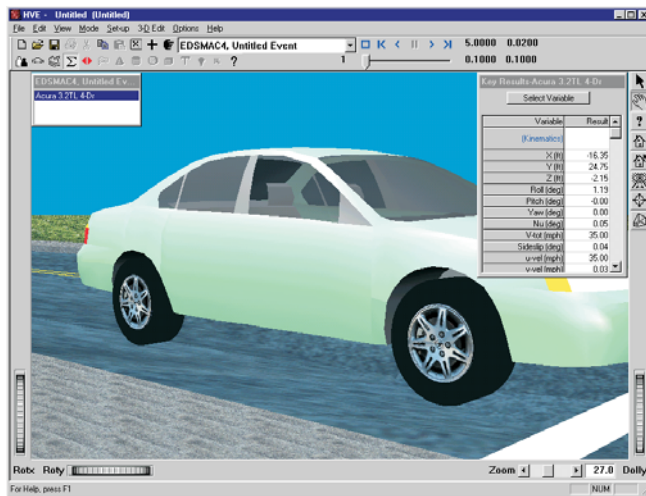


Technical Newsletter

Upcoming Enhancements to HVE and HVE-2D

Wheel Bitmap Images

An additional level of detail for a vehicle model will soon be available to HVE users. An additional function has been added to the Wheel Pop-up menu, allowing the user to apply a "texture" (photograph image) of the actual vehicle's wheel to the wheel of the vehicle model in HVE. Users can import bmp, tif and jpg images that are formatted to be 128 x 128 pixels in size, and display them on the vehicle. During a simulation, the wheel image will rotate at the wheel speed calculated by the simulation model. This feature provides enhanced visualization of wheel speed, such as the simulation of the vehicle under heavy braking with and without ABS, where it can be clearly seen if a wheel has become locked up or not.



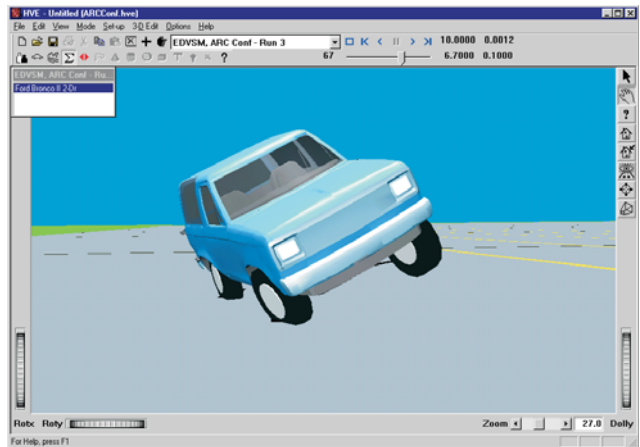
Actual photographs of the vehicle's wheels can now be displayed on the vehicle model in HVE, such as shown on this Acura 3.2TL used in an EDSMAC4 simulation.

Cut and Paste from Variable Output

Users of both HVE and HVE-2D will soon be able to select cells of the Variable Output report in Playback and copy and paste them directly into their spreadsheet or word processing programs. This makes it possible to eliminate the step of producing a text file of the output report and then importing the data into another program for additional graphing/presentation purposes.

EDVSM Rollover Code Update

Additional development work on the tire model used in EDVSM has made the ability to simulate a rollover, without encountering calculations of excessive tire forces, much easier. This is particularly useful for simulations involving vehicles that roll multiple times. This new tire model will be available in the next release of EDVSM.



Screenshot from an EDVSM rollover simulation at the point in time just before the vehicle tips over and begins a series of rolls.

Position/Velocity Hot Key

Users of both HVE and HVE-2D will soon be able to quickly access the Position/Velocity dialog for a vehicle simply by pressing Ctrl + P. In the current release, the Position/Velocity dialog is only available by selecting Set-up, Position/Velocity from the main menu. This enhancement will save users time and make it easier to set-up events, especially when working with multiple vehicles such as in an EDSMAC4 collision simulation.

DyMESH 3-D Collision Algorithm

The DyMESH 3-D Collision Algorithm for SIMON is undergoing validation of vehicle-to-vehicle collisions. The results are being validated against well instrumented staged crash tests. An update on the capabilities of DyMESH will be published in the next newsletter

Technical Session

This Technical Session explains how the “Steer Degree of Freedom” works. First a definition: The term “degree of freedom” means that a particular motion is determined by its equations of motion using Newton’s 2nd law. In the case of the steer degree of freedom, there is a single equation of motion. That equations defines the angular acceleration of a single wheel assembly about its steer axis. In Newton’s 2nd law form,

$$\Sigma M = I_s \ddot{\delta}$$

where

ΣM = summation of external moments acting about the steer axis to resist wheel steer

I_s = rotational inertia of the wheel assembly about its steer axis

$\ddot{\delta}$ = angular acceleration of the wheel assembly about its steer axis

Rotational Inertia

Note that we’ve used the term “wheel assembly”. That’s because we’re concerned with the total rotational (angular) inertia of the wheel. That would also include the brake rotor and caliper and the steering knuckle. The rotational inertia of these objects is normally small compared to the wheel and may often be ignored.

External Moments

There are three basic sources of external moments acting on the wheel assembly. These are

- Steer torque produced at the tire-road interface
- Frictional torque in the steering system
- Steering stops

Steer torque occurs because the point of application of tire force lies a distance away from the point where the steer axis intersects the ground plane (see Figure 1). This produces a moment about the steer axis. The distance from the point of force application to the intersection of the steer axis with the ground plane is the moment arm.

Frictional torque exists in the spindle (solid axle suspension), upper and lower ball joints (upper/lower control arm-type independent suspension) or shock tower and lower ball joint (strut-type independent suspension). Frictional torque also exists in the steering gear and steering column.

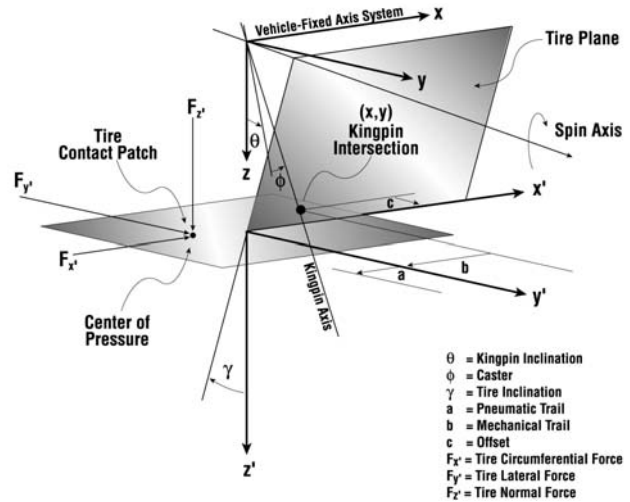


Figure 1 - Steer axis intersection with ground plane produces a moment arm about steering axis

The steering stops ultimately produce a moment that limits the left and right steer angles. While the steer torque and frictional torque exist throughout the full range of steering (lock-to-lock), moments from the steering stops exist only at the limits of the steering range, (i.e., full left or full right steering).

A mechanical model of the steering system is shown in Figure 2.

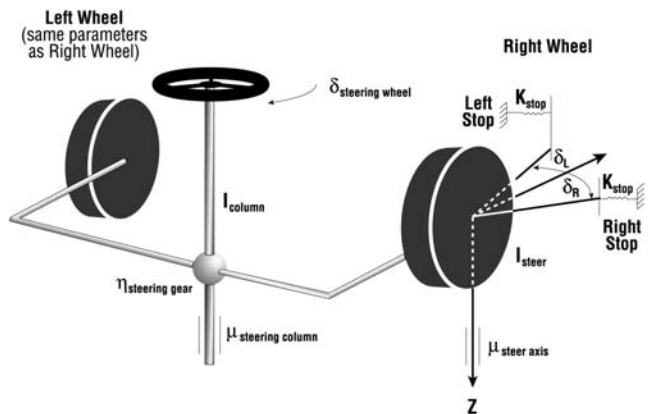


Figure 2 - Steering system model

Angular Acceleration

Because the external moments and rotational inertia are known, we have a single equation with one unknown: the angular acceleration of the wheel about its steer axis. Thus, the angular acceleration is

$$\ddot{\delta} = \frac{\Sigma M}{I_s}$$

Application

By far the most useful application of the steer degree of freedom model is the simulation of post-impact trajectory.

Referring to Figure 1, while a vehicle is traveling straight ahead, F_x is small (existing because of rolling resistance) and F_y is approximately zero. Also, the moment arms for F_x at the left and right wheels are such that their resulting moments cancel each other. Thus, there is no significant total steering moment produced during straight ahead driving (this, of course, is a good thing!).

On the other hand, consider a car sliding sideways (as often occurs during a post-impact spinout). In this case, F_y is quite large and the moments *do not* cancel – in fact they are additive. Thus, a significant steering moment is produced while a car is sliding sideways after a collision. This is well modeled by the steer degree of freedom and can easily be visualized in either SIMON or EDVSM. To illustrate this point, set up a simulation with an initial sideslip angle of, say, 45 degrees and turn on the steer degree of freedom (Calculation Options dialog). Execute the simulation. You will see how the resulting trajectory is affected by the steering induced at the tire-road interface. You can track the actual steer angle at each wheel in the Key Results window; see Wheel Data Group, Delta). To better visualize the actual steering, you can attach the camera to the vehicle. Position the camera at a distance of about 25 to 50 feet ahead of the vehicle and looking back at the vehicle. You will see the wheels steer as the vehicle progresses towards its rest position.

The steer degree of freedom is a relatively new tool and is not yet all that popular. That should change!

Custom Vehicle Models

Many HVE and HVE-2D users are taking advantage of one of the vehicle data services offered by EDC. These users receive the benefit of having the exact vehicle they need for a case (which they typically bill directly to the client), plus they can apply the price of that vehicle towards their next Update/Technical Support renewal.

Here is how it works: If a vehicle required for your case is not already available from the EDVDB vehicle database, EDC can provide you with the complete vehicle, ready to use in HVE or HVE-2D. Based upon the specific details on your order form, EDC will locate and measure all the data necessary to perform a complex reconstruction or simulation with that vehicle. This includes a body geometry file containing 3,000+ polygons (not including tires and wheels).

Your vehicle's geometry file and data set will be delivered to you immediately when completed. The vehicle will also be added to the EDVDB database, and made available to new and supported users in the next release.

The typical cost for a complete vehicle (data parameters and geometry file) is \$950.00 for a passenger car. By comparison, some sources of 3D models of vehicles charge hundreds to several thousands of dollars just for the 3D model, not including any additional performance parameters. Other sizes and types of vehicles are available, and are priced on a case-by-case basis. For more information about having a vehicle built for your case, contact EDC Customer Service.



Using the FARO digitizing arm to measure the exterior of the vehicle for the geometry file.

DXF Translator

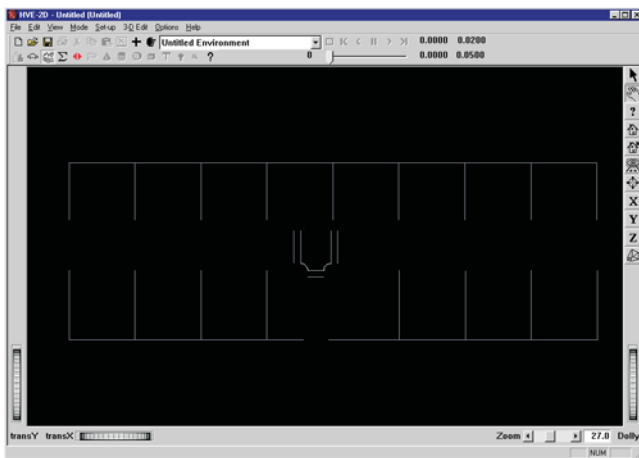
The most frequently asked question since our last newsletter has been “How can I get my DXF line drawing completely into HVE-2D?” This page is dedicated to the explanation of the best procedures to follow to import and use your DXF files.

Please follow these recommendations to prepare your line drawing in AutoCAD (if you are using a different program than AutoCAD, you may still be able to use these same recommendations):

1. **When drawing lines in your CAD program, use POLYLINES with at least three points!** We have found that polylines defined with three points will remain the same color when processed through the current DXF translator in HVE-2D. Two point polylines may not retain the same color, and they may not be processed through the translator as expected. Polyines with three or more points retain their color, are editable as separate objects in the 3-D Editor, and will not be lost during the translation.

Other useful tools to create 2D line drawings in AutoCAD are ARCS, RECTANGLES, and CIRCLES. (Tools to avoid are NORMAL LINES, BLOCKS, or X-REFS)

2. Locate the origin (0,0,0) in your CAD program at a point on your line drawing that will be convenient to use in HVE-2D. HVE-2D recognizes the origin (0,0,0) of the World Coordinate System (WCS) in AutoCAD as the origin of the line drawing when it is imported. If (0,0,0) is not located on your line drawing in a convenient reference location for your



DXF drawing that has been imported into HVE-2D and is obviously missing lines and colors. The user needs to follow the recommendations listed above.

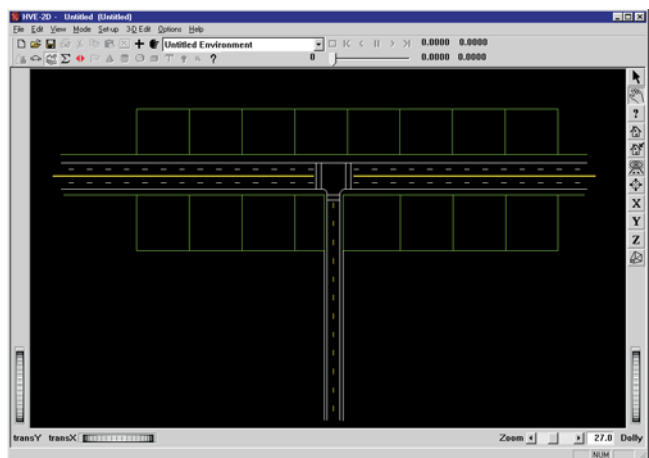
simulation work, you should move your line drawing in AutoCAD so that it is.

3. Use the *Export* or *Save As* feature in AutoCAD to save the line drawing as a R12, R13, R14, or 2000 dxf file format. Always try to use the DXF format for the version of program you are using. If you are using AutoCAD R14, try using the R14 format. If you encounter any problems with importing your file into HVE-2D, then go back and save the file as the next older DXF version available. This can result in a change of data structure within the DXF file and allow you to import the drawing into HVE-2D.

Please follow these recommendations to modify your DXF file using two functions provided in the Options section of the Environment Information dialog:

1. HVE-2D uses the SAE coordinate system where the Z-axis is positive into the Earth. AutoCAD uses a coordinate system where the Z-axis is positive away from the Earth. When you import a CAD drawing into HVE-2D, the Z-axis will point down, which results in your drawing appearing to be “upside down”. Use the *Flip About X-Axis* function to have your drawing appear “right side up”.
2. If the line drawing was not drawn in inches in your CAD program, use the *Scale Factor* functionality to convert the drawing units to inches. (e.g. Use 12 to convert from feet to inches)

If after carefully following all of the recommendations you are not able to import the DXF file into HVE-2D as expected, then EDC may be able to help with some additional translation. You will need to provide EDC with your drawing file in an AutoCAD R12 DXF format. Please contact EDC Technical Support for assistance.



The same DXF drawing has been prepared using the recommendations above and successfully imported into HVE-2D. It is ready to use!

User Hints and Tips

This section contain useful hints and tips to help HVE and HVE-2D Users make the most of their software.

- Need to produce a different graph of your Variable Output than just a selected variable vs time? Print the results of your Variable Output report to a text file. This will allow you to import the results into your spreadsheet program as a fixed width format text file. Refer to page 2-62 of the HVE User's Manual, or page 2-51 of the HVE-2D User's Manual for specific details.
- Want to print out a sharper, crisper image of your Traj Sim than what you are able to produce directly from using *File, Print* on the Main Menu? Try capturing the active window and pasting it into Microsoft Paint or directly into your Word document. This will produce a higher resolution image that what you will produce via your printer. Plus you get the added benefit of being able to have it where you want it in your report, rather than having to just attach it at the end. You can also capture other views, such as the Event Viewer with the current simulation time and Key Results displayed, which many users like to have to present as a series of stills of their simulations. To capture the active window, press *Alt + Prt Sc* on your keyboard. Then simply use the paste command in your other program. To capture the whole desktop, just press *Prt Sc* and then paste it into your other program.
- Have you added a friction zone surface to your environment model and would like to have it blend in better? Try placing the surface on it's own overlay and then turn the overlay off. This will hide the surface from your view, but not from the physics calculations. The vehicles tires will still "see" the friction factor assigned to that surface, and the results will be the same whether the overlay is turned on or off.
- Having trouble matching post-crash vehicle trajectories between your EDSMAC4 simulation and the actual measurements from the crash site? It may be because of a deflated tire or a dislocated wheel during the crash. Try using the tire blowout or wheel displacement setup capabilities within EDSMAC4 to account for actual damage to the vehicles tires. This may help account for the change of tire/terrain contact conditions that frequently occur during a crash.

USB EDKEY Available

Users of HVE and HVE-2D now have the choice between a parallel port or a USB EDKEY. An EDKEY allows the user to install their software on any number of computers, such as a laptop and a desktop, and run the software on the computer of their choice simply by inserting the EDKEY into the computer. The USB EDKEY may offer users easier access to their key, depending upon their hardware configuration. The cost for the USB key is \$95, same as for the parallel port key.



EDVAP on Windows XP

EDVAP users who have recently purchased new computers for their offices have found they have not been able to run their EDVAP (DOS) programs. This is due in part to the computer hardware processor/bus speed and also the Windows XP operating system. EDVAP users who want to continue to use their reconstruction and simulation programs are advised to upgrade to HVE-2D, which is compatible with the latest computer hardware and Windows operating systems.

NTSB Releases Additional HVE Simulation Movies

The National Transportation Safety Board (NTSB) continues to use HVE in their major accident investigations of buses, trains and tractor-trailers. Simulation movies from two recent studies are now available to download from their websites as follows:

Collision Between Tractor/Semi-Trailer and School Bus
Mountainburg, Arkansas - May 31, 2001

www.ntsb.gov/events/2002/intercession/int_ani.htm

Collision Between an Amtrak Train and a Tractor-Trailer Combination Vehicle Grade Crossing Accident, Intercession City, Florida - Nov 17, 2000

www.ntsb.gov/events/2002/MountArk/mount_ani.htm

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: Every time I open my case files, the main title bar displays HVE-2D - Untitled (filename.hve) or HVE - Untitled (filename.hve). Why does it say Untitled?

A: When you save a case, the Save As dialog appears and in this dialog there is a field for Filename and a field for Case Title. The default case title name is Untitled, and if this field is not edited the title listed above will be displayed. If you change the default case title to something like EDSMAC4 Barrier Collision, the main title bar will display:

HVE - EDSMAC4 Barrier Collision (filename.hve)
 HVE-2D - EDSMAC4 Barrier Collision (filename.hve)

Q: When I start my HVE or HVE-2D program, I see a message that indicates a license file was not found and I am running in Demo Mode. I'm sure I have a license. Why am I getting this message?

A: When the software starts, the license manager checks for a valid license file. If a license file is not found or if the license file is not validated properly, then you will receive this message. If you believe you have a license properly installed on your computer, try the following steps to troubleshoot the installation:

1. The HVE (and HVE-2D) software version numbers and the license file version number must match exactly. If you just installed an update, did you use the new license diskette with the same version number as the update?
2. When you purchased your software, did you choose to lock it to your computer or did you purchase an EDKEY? If your software is locked to an EDKEY, is the EDKEY plugged into your computer? (Believe it or not, this happens quite often!)
3. If you are using a parallel port EDKEY and you have other hardware locks installed (such as AutoCAD, 3D Studio), try plugging only your EDKEY into the computer.
4. Click on Start, Programs, HVE-2D (or HVE). In the list of programs, run the program *Show Computer ID*. The first line displayed in the dialog is "Locking Code 1" and is based upon the computer hard drive serial

number. The second line is the "Locking Code 2" and is based upon the EDKEY plugged into your computer.

If you have an EDKEY, you should see Locking Code 2 of 80-xxxxx. If you cannot run HVE-2D, but see 80-xxxxx displayed, then jump down to Step 6.

5. If you see Locking Code 2 of 0 - 0, then that means that the EDKEY is not being read. Follow these steps to see if the driver for reading the key is working:

A. Go to C:\Program Files\Rainbow Technologies\Sentinel System Driver and run the program SetupSysDriver.exe.

B. In the dialog that is displayed, you should see an Installed Driver Version and it should be Version 5.39 for Windows. If it does, then proceed to Step 6. If it indicates that the driver is not available, then this is your problem. You will need to run the Add/Remove Programs utility in Windows and remove the Sentinel System Driver program. Now, you will need to reinstall the HVE-2D software, as it includes the Sentinel System Driver at the end. Restart your computer after the installation. Now run the SetupSysDriver.exe program again and see if it is running now.

6. If you read the Locking code 2 as 80-xxxxx, check that the license file matches that code. Using a file browser, go to your HVE-2D (or HVE) folder and locate the file named lservrc. Open this file using Wordpad or Notepad. You should see lines at the top for your User-ID number, your company name, and also the code for your key. The 0x-xxxxx code in the license should match your 80-xxxxx code.

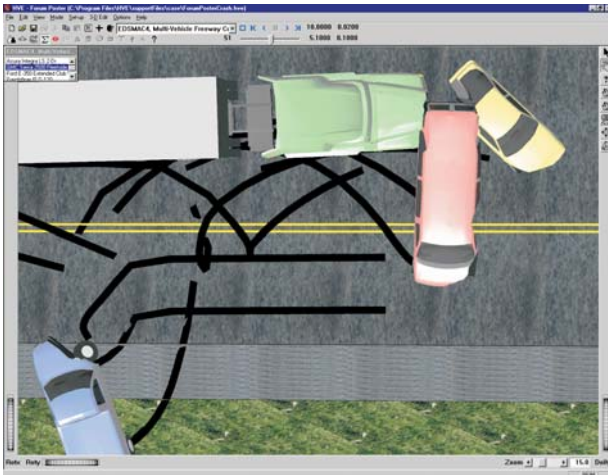
If you have not resolved your license problem by following these steps, please contact EDC Technical Support for assistance.

Q: How do I change the background color of my line drawing from blue to some color that more closely resembles a road?

A: If you are using a line drawing, what you see as the "background" color of the drawing is actually the Sky of the environment. If you don't want to deal with creating a surface and assigning colors in the 3D Editor, you can simply import your line drawing and set the Sky color to be the color of the "road". This can be done in the Environment Information dialog when adding a new environment. Press the button for *Sky Attributes*, then *Set Sky Color*, and then set your color using the color wheel. To get a nice Grey road click on the center of the color wheel and then drag the color intensity slider down to about 0.5.

Product Overview

Now that HVE and HVE-2D share a similar user interface, a brief overview of the capabilities of each product may be helpful for your selection of which physics program to use for your work:



Example of a multiple vehicle EDSMAC4 collision simulation in HVE-2D. Note the view is only available from an overhead position.

HVE-2D - simulation environment allowing user to select and edit vehicle and environment models for use in yaw-plane analyses. Available calculation methods allow the study of vehicle crashes and loss-of-control scenarios on flat roadways. Camera is fixed to an overhead view.

EDCRASH - allows the study of conditions of impact, including impact speed and delta-V of single and two vehicle crashes.

EDSMAC - allows the study of single or two vehicle crashes.

EDSMAC4 - allows the study of multiple vehicle collisions as they happen in real life, including articulated vehicles, fixed barriers, wheel deflation and displacement due to damage.

EDSVS - allows the study of single vehicle response to driver inputs, including loss of control

EDVTS - allows the study of vehicle - trailer response to driver inputs, including loss of control

EDGEN - generic kinematics spreadsheet utilizing linear or spline algorithm calculated motion of vehicle based upon position and velocity at position.

EDVDB - vehicle database containing ready-to-use vehicles. Includes digitized exterior body mesh, stiffness coefficients and performance parameters used in reconstruction and simulation models.



HVE - simulation environment allowing user to select and edit human, vehicle and environment models for use in true 3-dimensional analyses. Available calculation methods allow the study of real-world vehicle handling, including limit maneuvers and rollovers, crashes on both flat and irregular terrains based on road surveys. Use of HVE Brake Designer allows detailed study of brake system performance. Study of occupant motion and vehicle-pedestrian collisions is also possible.

All programs available for HVE-2D can be used in HVE, with the added benefit of recognizing driving on the terrain model. EDGEN in HVE also allows the use of a human model. EDVDB in HVE provides the complete 3-D performance parameter dataset for the vehicle.

EDVSM - allows the study of 3D vehicle response to gradual or sudden air loss in tires, irregular terrain surfaces, and driver inputs - especially for limit maneuvers resulting in loss of control and rollover.

EDVDS - allows the study of loss of control of commercial vehicles (with up to 3 trailers) in situations including brake imbalance, trailer off-tracking and rearward amplification, and the effect of payload position on stability.

SIMON - has similar capabilities as EDVSM and EDVDS, and includes recognition of occupant as payload and use of ABS simulation model. Also uses DyMESH 3-D collision algorithm (when available).

EDHIS - allows the study of a single occupant during a crash.

GATB - allows the study of single or multiple occupants during a crash, or for pedestrian.

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 20 - 24, 2003

Miami, FL November, 2003

EDC Reconstruction

Los Angeles, CA January, 2004

Miami, FL November 11 - 15, 2002

Theoretical & Applied Vehicle Dynamics

Indianapolis, IN October 1 - 3, 2002

2003 HVE FORUM

Las Vegas, NV April 28 - May 2, 2003

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 no longer actively scheduling the COMPTAR and MATAR courses which used EDCRASH and EDSMAC. The material previously covered in these courses is available 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.

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