

# Technical Newsletter

## 2003 HVE Forum - Humans, Vehicles and Elvis?



"Elvis" Grimes challenging Jack Beemer with HVE related questions in a round of HVE Jillionaire during Monday night social hour activities.

The 2003 HVE Forum once again brought HVE and HVE-2D users together to learn more about their software and to network with other users in a relaxed environment. The Users Group Meeting, the HVE White Paper session and all of the workshops were well attended and received excellent reviews. As part of the week's activities, a special guest was invited to host the Monday evening Jillionaire game. The real Elvis couldn't have better hosted the game and helped contestants win "HVE Dollars" good towards the purchase of EDC products and services.

### 2004 HVE Forum - San Francisco, CA

Planning is already underway for the 2004 HVE Forum. Mark your calendar for the dates of May 3 - 7, 2004. The Crowne Plaza - Union Square hotel in downtown San Francisco, California, will serve as the conference hotel. Special room rates for attendees have been arranged with the hotel.

Registration forms, workshop schedules and workshop descriptions will be available for download from the EDC website. Please visit the 2004 HVE Forum page at [www.edccorp.com/service/hveforum.html](http://www.edccorp.com/service/hveforum.html).

### HVE White Paper Session

This year's papers presented topics of interest ranging from scene data collection, to vehicle loss-of-control simulation, to the study of possible injury causation of occupants during a crash. The following White Papers may be downloaded directly from the EDC website:

WP-2003-1 "Downhill Commercial Vehicle Simulations - Part A (Tractor/Semi-trailer Brake Fade)"

WP-2003-2 "Downhill Commercial Vehicle Simulations - Part B (Intercity Bus Equipped with an Engine Data Recorder)"

WP-2003-3 "Reconstruction of Real World Side Impact Vehicle Collisions Using HVE - A Case Study of Pediatric Pelvic Fracture"

WP-2003-4 "Investigating the Use of Simulation Model Non-linear (SIMON) for the 'Virtual Testing' of Road Humps"

WP-2003-5 "Constructing Detailed Road Surfaces for Vehicle Dynamics Simulation Using 3D Laser Scanning Techniques"



HVE White Paper Session Presenters posing for a quick group photo with Terry Day. (From left to right) Larry Jackson, Shresta Marigowda, Terry Day, Fabian Marsh, Iwan Parry and Yoganand Ghati.

# Technical Session

This Technical Session explains how the brake system on a 3-D simulation model (e.g., SIMON, EDVSM) works. 3-D simulation users will note that the driver brake table includes the *Pedal Force* option (2-D simulations, not having a brake system model, include only the *Wheel Force* and *% Available Friction* options; although these options may be available in some 3-D simulation models, they reduce the quality of the results and EDC does not recommend their use).

The 3-D brake system model in the simulation works just like it does in a real vehicle. It starts with the driver pressing the brake pedal (in the simulation, this is presented as a table of brake pedal force vs. time). The master cylinder converts this force to brake system pressure (in the simulation, this is called the *Brake Pedal Ratio*). The system pressure may then be reduced through a proportioning valve (modeled by a *Threshold Pressure* and *Proportion Ratio*). Next, the system pressure may be modulated at each wheel by an ABS system. This modulation is controlled by a computer software algorithm in the simulation, just as it is on the actual vehicle. Finally, the system pressure is converted to brake torque by the wheel brake assembly. The simulation calls this the *Brake Torque Ratio*. The entire process is shown schematically in Figure 1.

So, how does the resulting brake torque actually result in braking? In addition to equations of motion for linear motion (X,Y,Z) and rotation (roll, pitch, yaw), 3-D simulations also have equations of motion for wheel spin. Application of first principles to wheel spin,  $\Omega_{Wheel}$ , results in:

$$\Sigma M = Brake\ Torque - F_{X_{Tire}} = I_{Spin} \ddot{\Omega}_{Wheel}$$

From this, wheel spin acceleration,  $\ddot{\Omega}_{Wheel}$ , is calculated (*Ispin* is constant and *Brake Torque* and  $F_{X_{Tire}}$  for the current timestep are known):

$$\ddot{\Omega}_{Wheel} = \frac{Brake\ Torque - F_{X_{Tire}}}{I_{Spin}}$$

Numerical integration is used to update the spin velocity of the wheel for the start of the next timestep. Using this spin velocity and the current tire radius,  $R_{Tire}$ , (also known), the linear velocity,  $V_{X_{Tire}}$ , at the tire contact patch is calculated:

$$V_{X_{Tire}} = \dot{\Omega}_{Wheel} \cdot R_{Tire}$$

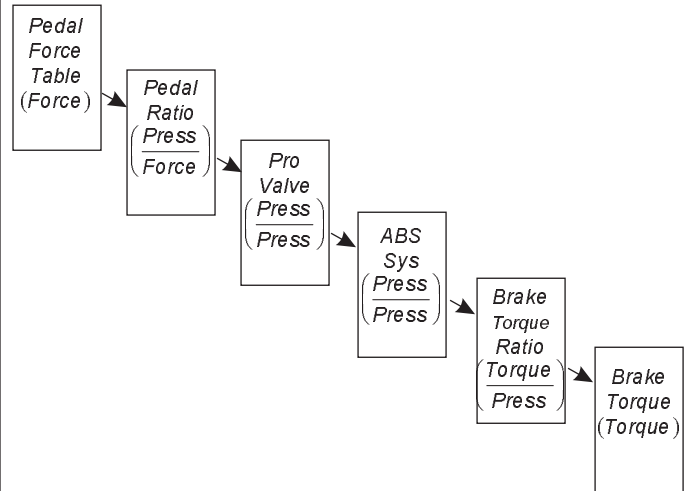


Figure 1 - Schematic flow of 3-D brake system simulation model

The tire longitudinal slip is then:

$$Slip = \frac{V_{Wheel\ Center} - V_{X_{Tire}}}{V_{Wheel\ Center}}$$

The tire's friction (mu vs slip) data are then used to determine directly for the start of the next timestep the longitudinal braking force,  $F_{X_{Tire}}$ .

Earlier we said that the *Wheel Force* and *% Available Friction* brake table options were not recommended. It is now clear why: Use of either of these methods bypasses completely the wheel spin equations of motion. Any details related to tire spin dynamics are completely lost. Obviously, ABS simulation is also not possible when either of these options is used (refer to the December 2001 Technical Newsletter for more details).

A question sometimes asked by new 3-D users is, "How can I tell how much pedal force to use?" There are a couple of ways to answer this question. First, you have your common sense and years of actual driving experience. Think about it: You probably apply around 10 lb during a normal brake application, and maybe 50 lb (or more) during heavy braking. If you're the analytical type, here's a method for you: First, create a brake table that varies from zero force at time zero, and increases to 100 lb at 5 seconds. Start the vehicle at a high speed, say 80 mph, and execute the run. Then produce a graph of Forward Acceleration vs Brake Pedal Force. *Voila!* You now know precisely how hard to press the brake to achieve a desired deceleration.

## HVE Brake Designer

As shown earlier, *Brake Torque Ratio* is one of the key players in the calculation of brake torque. By default, *Brake Torque Ratio* is a single lumped parameter assigned for each wheel and editable by the user. However, we can go a step further: *Brake Torque Ratio* can also be calculated using the mechanical and geometrical properties in the individual brake assembly. The HVE Brake Designer does exactly that.

Different types of brakes (disc, various types of drums, S-cams, wedge, etc) are mechanically different from each other. Free-body diagrams of the forces acting between the pads and rotor (or shoes and drum) are used to compute the brake torque ratio for each of eight-different user-selectable brake types. The brake torque ratio will also vary as changes in brake temperature dynamically affect lining friction. Thus the model allows for a very thorough analysis of brake failure mechanisms. A good example of this is the study of marginal brake adjustment on the ability of a truck driver to maintain control while traveling over a long down-hill grade. See the following three articles for examples: SAE Paper No. 200-01-1294, September 1999 EDC Technical Newsletter, WP#2003-5. Contact EDC if you would like to receive copies of these articles.

## ABS

An ABS (Anti-lock Braking System) system is an optional component that, when present, plays a major role in the calculation of brake torque (see Figure 1). ABS works by reducing brake system pressure, and therefore brake torque, so as to prevent wheel lock-up. This task is accomplished by monitoring the current longitudinal tire slip (actually, it is the wheel spin velocity and acceleration that are being monitored by the ABS computer; longitudinal tire slip may then be inferred). When tire slip reaches a specified level, system pressure is quickly dumped from the brake, thus allowing the wheel to again spin freely. Pressure is then allowed to rebuild. The main goal of this process is to keep the tires rolling so the driver can steer the vehicle. Reduced braking distance is a secondary benefit.

For more information about calculating brake torque, refer to the HVE User's Manual, Section Eleven - HVE Brake Designer. Or contact EDC Technical Support - we're always glad to help!

## 2003 HVE Forum

### Top 10 Wish List

Each year at the HVE Forum, attendees to the User's Group meetings develop a "Wish List" of additional functionality or enhancements for HVE and HVE-2D that they would like to have EDC implement over the next 12 months. The groups suggestions are then narrowed down by voting for their Top 10 choices. Here are the lists from the 2003 HVE Forum:

#### HVE Users' Top 10 Wish List

1. DyMESH
2. Tire Model/Sidewall Contacts
3. Save Camera View
4. Accelerometer Tracer
4. Display Key Results in Playback Window
4. Print All Reports
5. Heavy Truck Air Suspensions
6. Add Vehicle to Existing Event
7. Dynamic Payload Shift
7. Elliptical Air Bags
7. Attach Camera to Follow Target
7. Tire Interaction With Other Vehicles and Humans
7. Retarders

#### HVE-2D Users' Top 10 Wish List

1. Path Follower
1. Create EDSMAC event from EDCRASH results (like EDVAP)
3. "Undo" Command (history of last 20 or so actions.)
4. Include open report windows in current object list, and enable minimize for all report windows in Playback
5. "Are you sure?" message when clicking intermediate position
5. Copy and paste contents of all report windows
7. Make EDCRASH damage profile visualized like v1.33 and EDVAP
7. Lock cursor's Z coordinate to zero in 3D editor, or allow to pick friction zone vertices in event viewer
7. Add, remove or switch vehicles in an existing event
10. Insert text into report windows

# Using Aerial Photos as Scene Drawings

Many users are working with aerial photographs as the background for their reconstructions and simulations. These photographs may be from a company hired to provide a specific digital image or downloaded directly from image libraries available on the internet as shown in Figure 2.



Figure 2 - Example aerial photograph of a crowded intersection obtained from a company specializing in providing aerial images over the Internet

There are different techniques for using these images, but the basic concepts are similar. You may need to manipulate the image in a photo/drawing editor program. Then, you can use the capabilities of the 3D Editor to apply a “material texture” to a surface and create your scaled site. Here are two approaches that you might consider:

Approach 1 - You may find it easiest to match a square image to a square surface in the 3D Editor. You will need to add background area or crop your image to make its dimensions a perfect square.

Approach 2 - You may choose to work with a rectangular image and use the translation and repeat sliders on the Material Texture dialog to match your image to the surface.

For either approach, follow these general steps:

1. Determine the size of the image in inches or pixels and also the scale of the image in feet per inch or pixel.
2. Make sure your image is saved in the proper location of /supportFiles/images/environments/EnvTextures. It must be in this location to be available as a texture in the 3D Editor.

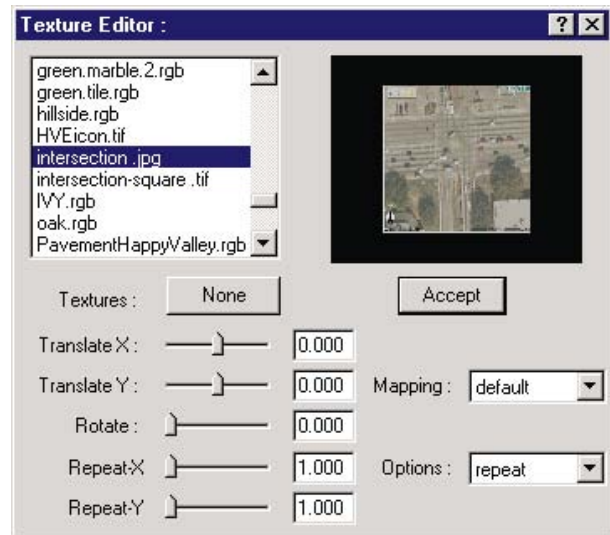


Figure 3 - Material Texture Editor dialog displaying the selected image to be applied to the surface.

3. Build a surface in the 3D Editor that corresponds to the size and shape of the image that you have created. If 1 inch equals 100 feet in your image and your image is 5 inches on edge, make the surface 500 feet.

4. After completing your surface and preparing it for editing, choose 3D Edit, Material Texture from the menu. This will display the Material Texture Editor dialog. Choose your image from the list of textures on the left hand side of the Material Texture dialog as shown in Figure 3.

5. Check the appearance of the image on the sample and adjust the rotation if required. Click the Accept button to attach the texture to your surface.

At this point, if you are using a rectangular image, you will need to adjust the Repeat and also the Translate settings for the image. The value used for Repeat will be the longest side of your image divided by the shortest side. For example 600 pixels divided by 300 pixels is a Repeat value of 2. This will shrink (scale) the texture which was stretched to a square in the Material Texture dialog back to the rectangular shape you started with. You need to click the Accept button to update your image displayed on the surface.

6. That's it! Now create an event and place a vehicle on your surface to test the scale of your scene.

As a side note, you could use the advanced capabilities of a 3D modeling program to create a 3D terrain model and then map an aerial photograph to the surface. This provides the scaled image appearance and also accounts for terrain irregularities and changes when vehicles drive on the surface.

## User Hints and Tips

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

- Not satisfied with the image quality of your movies, but don't want to change the video codec you are using? Try increasing the settings for Anti-Aliasing from 1 to at least 3. (It is best to do this just after you set your Destination to AVI, as it increases the time to refresh the screen.) You will see immediate improvements. Some users report adjusting the setting up to 10 to achieve a very clear, crisp image. The only drawback to increasing your anti-aliasing setting this high is the length of time your graphics card will take to refresh the screen. You'll have to try and decide for yourself. Remember, if you do turn up your anti-aliasing settings, be sure to set them back down to 1 after making the movie, otherwise your program will be very slow to respond.

## 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 try to run HVE and I immediately get an error message from Windows saying that the program failed to initialize. Why can I not run HVE?*

*A:* The error message you received probably read something like "The application failed to initialize properly (0xc000142). Click OK to terminate the application."

This error occurs when a Windows program (often running as a service) restricts access to OpenGL. When *HVE* starts it has to access OpenGL, so the restriction results in *HVE* failing to initialize. To correct the problem, you must stop the program/service that has exclusive control over OpenGL.

Two programs that we are aware of that cause this problem are *MatLab* and *PCAnywhere*. If one of these programs is running as a service, change the Startup Type of the service to Manual. Or you can "disable" the *MatLab* or *PCAnywhere* program temporarily by right-mouse clicking on their icon in the Taskbar Notification Area and then choosing "disable" or "exit".

If you find other programs that cause this problem, please contact EDC Technical Support.

*Q: Can I make a QuickTime format movie directly from the Playback Window?*

*A:* No. The Playback Window produces an AVI format movie. If you need to produce a different format of movie, such as QuickTime or mpeg, you need to convert the movie using a movie editing program such as Adobe Premier.

*Q: I've been working on the main collisions of my multiple vehicle crash simulation, but now I want to add an additional vehicle to my EDSMAC4 event? Is this possible?*

*A:* No. When you first created the event, you selected all of the objects that would be allowed in the event. You cannot add or remove any vehicles from the event. However, you have two possible choices to consider. One is to recreate your entire event and add the additional vehicle initially. The other is to add an additional event with only the new vehicle and then combine the Traj Sim sequences together in the Playback Window to complete your sequence.

*Q: I have a 16 second simulation run, but I only want to make a movie of the action from  $t = 5$  seconds to  $t = 13.6$  seconds. I've tried moving the slider to select the correct starting frame, but when I change the Destination to AVI and press the Play button to begin recording, the sequence starts from the beginning  $t = 0$ . Do I have to use an external movie editing program, or can I somehow do this within the Playback Window?*

*A:* You can do this within the Playback Window. What you need to do is to **play** the sequence forward from the beginning to the point where you want it to start recording. (Don't try to use the slider to set it to a starting frame). Press the Pause button to stop the sequence and then change your render settings (if desired). Change the Destination to AVI and press the Play button. Your movie will begin recording from that frame forward. When you reach the point where you want to stop the recording, press the Pause button and change your Destination back to the Playback Window. When you view your AVI, you will see that you have recorded the exact sequence you wanted to.

## 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](http://www.edccorp.com) and follow the links to Support.

## Contributors Corner

Interested in learning how to improve the appearance of the textures applied to your environment model? Here is a method submitted by user Eric Deyerl for smoothing out texture maps to reduce the “tiling” effect which often occurs when using a texture map available straight out of the box.

As an example, let’s look at a texture map intended to represent a concrete surface in HVE. This texture map is stored as a file named “cement.tif” which is located in the /supportFiles/images/environments/EnvTextures directory within the HVE program directory.

If you used HVE’s 3D Editor and created a rectangular roadway surface with dimensions 50 feet by 200 feet and applied the standard “cement” texture to the surface at a repetition of 2.5 cycles in X and 10 cycles in Y, you’d get the environment model shown in Figure 4.

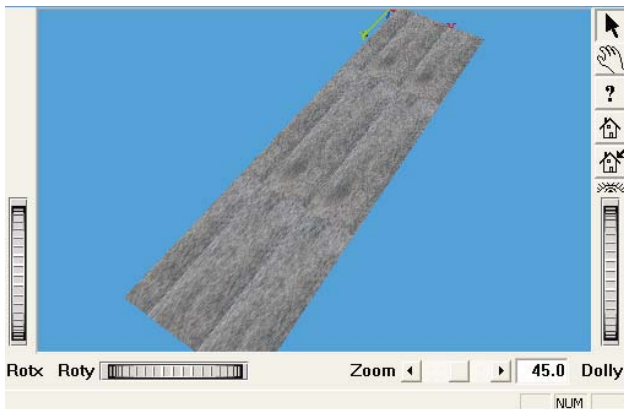


Figure 4 - Roadway with unsmoothed concrete texture map

A viewer of the scene gets the general idea that the surface is comprised of concrete, but the effect is not entirely realistic because of the pronounced tiling effect created by the repeated square boundaries of the applied texture.

This effect can be reduced by modifying the edges of the texture map so that they match better when the pattern is repeatedly applied to a surface. Here’s how.

First, open the texture map within an image editing application. This article will describe how to modify the texture using Adobe Photoshop 7.0, but other software packages should have similar features. Before proceeding further, be sure to save the file with a different name so you can experiment freely without fear of losing the original file.

Next, use the Image/Image Size command to determine the dimensions of the texture map in pixels. The cement.tif texture supplied in HVE is 256 pixels by 256 pixels.

Next, engage the Filter/Other/Offset command. In the window which appears, enter the values of “128” in the “Horizontal” and “Vertical” boxes, and put a check in the box labeled “Wrap Around”. This will cause the texture to be shifted exactly half its dimension in both the vertical and horizontal directions. By doing this, you have just created a texture tile whose pattern will match exactly with the edges of the tiles adjacent to it on all sides when the texture is repeated. Figure 5 depicts the results of the application of this filter in Photoshop compared to the original texture.



Figure 5 - Original texture map (left) and texture map with offset filter applied (right)

We’re not quite done yet, though. As you can see, the offset filter has eliminated the differences in patterns at the edges of adjacent texture maps, but it has created a pair of vertical and horizontal discontinuities which run across the middle of the texture. To minimize this effect, click on the “Clone Stamp” tool in Photoshop. Use this tool to copy smooth areas of the texture onto the hard discontinuities across the middle of the texture.

To make this effect realistic, use a medium-sized brush with a feathered edge from the Brushes palette (a 45 pixel brush works well). You may have to make multiple attempts to get the effect just right. Also, take care not to modify the texture near the edges of the map, as the edges by definition already match perfectly from the application of the offset filter, and any changes to the texture near the edges will destroy this effect. Figure 6 depicts the texture after manipulation with the Clone Stamp tool.



Figure 6 – Texture map after offset filter and smoothing via the Clone Stamp tool

You've now completed the modification of the texture map. Try applying the new texture to the roadway surface you created in HVE. Compare it with the surface mapped with the unmodified texture, and you'll likely find that it appears smoother and more realistic as shown in Figure 7. You'll notice that there is still repetition in the surface – the texture map has been smoothed but is, after all, still being repeated. However, the effect is now less noticeable. Now, your vehicles will appear less like they are traveling across a dance floor. Good luck!

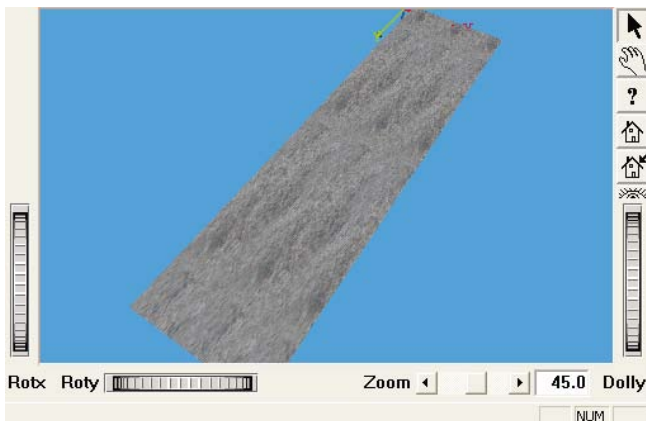


Figure 7 - Roadway with smoothed concrete texture map

If you have any questions or would like to discuss the techniques described in this Contributor's Corner article, please contact the author:

Eric Deyerl, P.E.  
 214 Main Street, Suite 303  
 El Segundo, CA 90245  
 (310) 615-2600  
 edeyerl@sbcglobal.net

## Suggested Computer Requirements: EDC Needs Your Help

We are constantly trying to offer advice to users about their choice of options and upgrades for computers they are considering purchasing for their office. However, it seems like there are new configurations of processor and graphics cards available every day of the year.

We need your help in determining if there are configurations out there that have problems with running HVE (HVE-2D). If you have followed all of the troubleshooting tips to try to correct your problems and are still experiencing random program crashes or not seeing all of the dialogs being displayed on your computer, please contact EDC Technical Support.

We have heard that some notebook computers and desktop computers with ATI Radeon graphics chipsets can provide extremely sluggish response when running HVE, or will not properly display environment models. Users have typically returned these computers and bought others with different graphics cards to avoid the problem, without ever telling us the make and model of the one that gave them problems. With so many different configurations out there, this is detailed information we really need to know! Using this information we will be able to pinpoint and study the issues and then identify solutions to overcome any problems.

## Call for Papers and Simulation Movies

If you are interested in presenting a technical paper in the "HVE White Paper" session or contributing a simulation movie to the "HVE Simulations Festival" for the 2004 HVE Forum, now is the time to prepare.

For the HVE White Paper session, please submit your abstract to EDC Customer Service before October 15, 2003. Please include complete contact information for the lead author with each abstract submission. If you would like to discuss possible topics for your paper, please call and talk them over with us.

For the HVE Simulations Festival, you are welcome to submit any simulation movies from previous cases, or to prepare an example of your own creation. Please contact us to discuss the format (file, tape, etc) that is best for submitting your movies.

# 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 10 - 14, 2003

#### EDC Reconstruction

Los Angeles, CA ..... January 19 - 23, 2004  
Miami, FL ..... November 2004

#### Theoretical & Applied Vehicle Dynamics

TBA ..... Fall 2003

#### 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](mailto: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.

---

Engineering Dynamics Corporation  
8625 SW Cascade Blvd, Suite 200  
Beaverton, Oregon 97008-7100 USA  
Phone 503.644.4500 / FAX 503.526.0905  
Email: [info@edccorp.com](mailto:info@edccorp.com)  
Website: [www.edccorp.com](http://www.edccorp.com)

EDVAP, EDCRASH, EDSMAC, EDSMAC4, EDCAD, EDSVS, EDVTS, EDHIS, EDVSM, EDVDS, EDGEN, EDVDB, HVE, HVE-2D, HVE Brake Designer and GetSurfaceInfo() are trademarks of Engineering Dynamics Corporation. All Rights Reserved.

SIMON and DyMESH (Patent number 6,195,625) are registered trademarks of Engineering Dynamics Corporation. All Rights Reserved.

GATB is a trademark of Collision Engineering Associates, Inc.