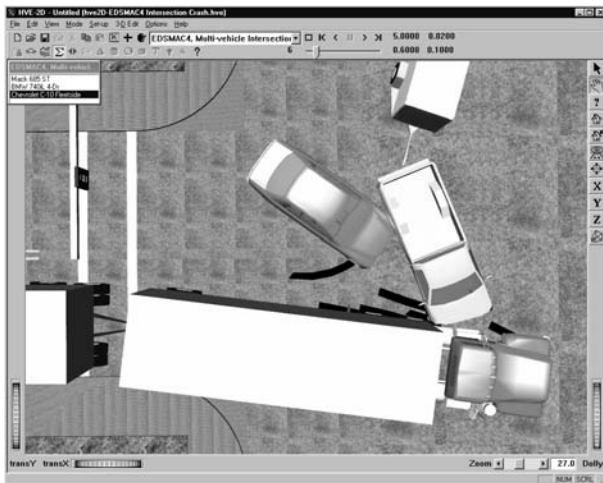


# Technical Newsletter

## Totally Redesigned *HVE-2D* Available In August

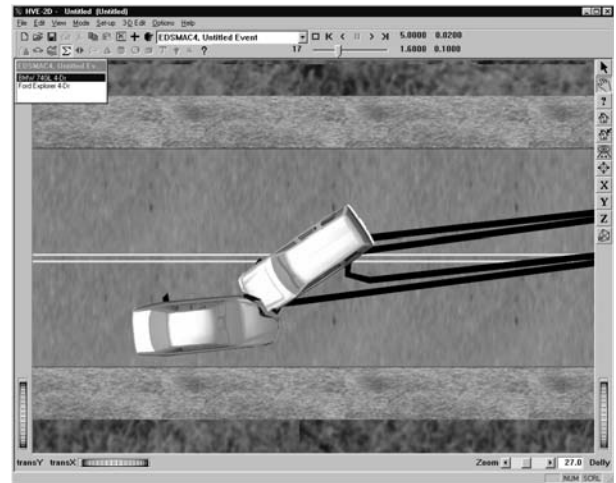
*HVE-2D* users will soon have their dreams come true. A totally redesigned *HVE-2D*, infinitely more robust and user-friendly than previous versions, will be available in August 2001. *HVE-2D* Version 2 will present the user with familiar menu options and functionality, but it is truly a total redesign of the whole program. Version 2 is in fact the new *HVE* Version 4 code, running in *HVE-2D* mode. One of the greatest benefits of this integration is that both *HVE* and *HVE-2D* users will be able to benefit from EDC's focused efforts on a single interface for program updates and technical support.



When a user receives their update in August, they will discover many new benefits, including:

- The new single window interface prevents the nuisance of “. . . those darn dialogs keep covering each other up.”
- Simulation movie files can be created directly within *HVE-2D*.
- Casefiles from *HVE-2D* v2 and *HVE* v4 are now fully compatible, allowing all users to easily share their work across platforms.

- The flexibility of using an EDKEY or a hard drive volume number for licensing.
- The choice of working with a simple line drawing of a crash site or with a realistic appearing model with multiple colors and shading.



*HVE-2D* users will also want to take advantage of two new physics programs (*EDGEN* and *EDSMAC4*) now available for *HVE-2D*. *EDGEN* is a kinematics spreadsheet which uses positions and velocities supplied at up to eight user-specified locations to determine the time required to travel between each location. *EDSMAC4* is a simulation analysis of single- or multiple-vehicle crashes, including articulated vehicle crashes and crashes involving more than two vehicles.

The required modifications and testing of the current *HVE* code to allow for *HVE-2D* operation *have already been completed!* *HVE-2D* Version 2 is currently undergoing an extensive feature review and will be shipped to all supported users in August. *HVE-2D* users who wish to participate in the feature review are urged to contact EDC Customer Service for more information.

## HVE-2D Version 2 Unveiled at 2001 HVE Forum

“See What’s Hot!” is exactly what attendees did at the 2001 HVE Forum held last month in Santa Fe, New Mexico. Potentially the “hottest” news of all was announced during Terry D. Day’s opening remarks when he unveiled a totally redesigned HVE-2D. This new version of HVE-2D is the same code as HVE Version 4 and provides HVE-2D users with new functionality, stability, and even greater capabilities with the addition of EDSMAC4 and EDGEN.



The unveiling of HVE-2D Version 2 during opening remarks.

Again this year, users from around the world spent the week attending workshops focused on the theory and application of HVE and HVE-2D compatible physics programs to their type of work. Most attendees brought their laptop computers and worked through examples provided by the instructors.



Forum attendees eagerly awaiting the start of the week’s activities.

Evaluation forms indicated that everyone felt the material covered was very beneficial and would recommend the HVE Forum to anyone interested in learning more about HVE and HVE-2D. It was also commented that the Forum was a great opportunity to network with other serious professionals in the industry.

Workshops for next year’s HVE Forum will be redesigned to provide attendees with even more “hands-on” time for real-world examples.

Based on the results of the voting held during the User’s Group meetings, the 2002 HVE Forum has been set for May 13-17, 2002 at the Sheraton Hotel in New Orleans, LA. Workshop descriptions and registration forms will be available later this year and may be downloaded directly from the HVE Forum pages on our website. Mark your calendars now and plan to attend! See you in New Orleans!

## HVE-2D Version 2 Updates

As indicated on the front page of this newsletter, HVE-2D users will be receiving HVE-2D Version 2 in August. All supported users will receive Version 2 as part of their regular Update/Technical Support policy, even though Version 2 could be considered a brand new program for all of the redesign, development and over 5 person-years of testing that have been completed. Long-time users will find that the new interface “drives like a Rolls-Royce”.

The Version 2 update will include EDGEN as a free addition to the current physics programs owned by the user. The user has the choice to add the EDSMAC4 crash simulation program to allow them to simulate multiple vehicle crashes, crashes involving articulated vehicles and even vehicle-to-barrier crashes. Also, the user can choose whether to use an EDKEY or a serial number for licensing.

Since the user interface has changed significantly, this software update will include a full set Operations and Physics Manuals. Users are encouraged to install Version 2 and take it for a test drive. Version 2 will install as a new program and not overwrite an existing HVE-2D installation.

For more information about HVE-2D Version 2 and to place your order for EDSMAC4, please contact EDC Sales.

## **HVE Version 3.1 Now Shipping**

HVE users (using SGI workstations) will be receiving their update to HVE v3.1 about now. This update provides SGI version users with many of the improvements to the user interface and the physics models already implemented in HVE Version 4.1.

SGI users will want to install this latest update as soon as possible, especially if trying to make any comparisons with runs using the latest PC version. The SGI workstation version of HVE will continue to be supported.

## **HVE Version 4.1 Now Shipping**

The latest HVE update for the PC will be shipped to all supported users later this month. HVE Version 4.1 provides users with some improvements to the user interface and also includes the following new enhancements:

- Support for new EDCRASH features (see Major EDCRASH Update, page 4 in this Newsletter)
- Support for more than one steerable axle on a vehicle
- Additional support for the HVE Tire Blow-out Model and Virtual Accelerometers
- Updated Calculations Options Dialog for SIMON
- Significantly improved Installation program

## **GATB Available For HVE Version 4.1**

Collision Engineering Associates, Inc. (CEA), announces the release of GATB v 5.25, which is compatible with HVE v4.1. Users of the PC version of HVE will now be able to perform complex human occupant or pedestrian simulations using GATB. The human model used in the calculation method is represented by 15 inertial segments, allowing for the study of motion and interactions of extremities. For more information about GATB, please contact CEA, Inc. at 480.655.0399 or email to wgrimes@cea-az.com.

## **EDSMAC4 vs. EDSMAC**

Many long-time users of HVE-2D and EDSMAC will be wondering what major advantages there will be to using EDSMAC4 instead of EDSMAC for their crash simulation work. The following is an excerpt from the abstract of SAE Paper 1999-01-0102, "An Overview of the EDSMAC4 Collision Simulation Model":

"This paper reports on an extended version of the EDSMAC program, called EDSMAC4. These extensions resulted in significant changes to major portions of the original code. In particular, the control routine logic was revised to allow:

- simulation of any number of vehicles
- *simultaneous* collisions with multiple vehicles
- improved collision detection

The collision algorithm was extended with:

- an improved force-deflection model
- different stiffnesses for front, back and sides
- support for barrier crashes
- damage profile simulation/visualization
- support for articulated vehicle crashes

The vehicle dynamics model was extended with:

- support for tandem axles and dual tires
- calculation of load transfers
- support for wheel displacement during impact
- support for the tire blow-out model
- support for articulated vehicles

A copy of the complete paper may be obtained by contacting EDC Customer Service at 503.644.4500, or by downloading it directly from the Technical Reference Library section of the EDC website at [www.edccorp.com](http://www.edccorp.com). If you have any questions or would like to order EDSMAC4 for your HVE-2D system, please contact EDC Sales for further assistance.

## Major EDCRASH Update

EDCRASH has received its first major update in over ten years. This update includes the following new features:

- The ability to assign vehicle final velocity. This feature eliminates the need to assign pseudo-rest positions and greatly simplifies the reconstruction of crashes involving multiple impacts.
- The option to turn the *Common Velocity Check* on or off. This feature allows the effects of the common velocity assumption to be tested.

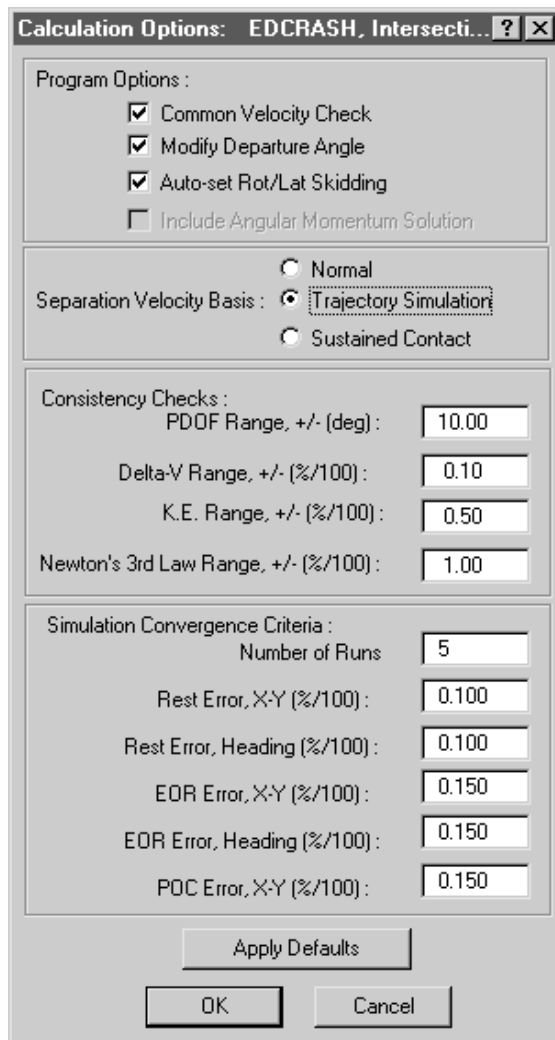


Figure 1: New EDCRASH Calculation Options Dialog

- The option to turn the *Departure Angle Correction* on or off. This feature allows the effects of the departure angle correction for specific types of post-impact paths to be tested.

- The option to have EDCRASH assign the status of the Rot/Lat Skidding check box. Users sometimes overlook this check box, or set it improperly. This feature automates the process, helping to ensure valid results.
- The option to have EDCRASH assign mutually compatible PDOFs. Similar to the asterisk option in EDVAP, this feature automatically assigns the correct PDOF for one vehicle based on the PDOF of the other vehicle and impact positions of both vehicles.
- User-assignable warning ranges for compatibility checks for PDOF, Delta-V, Kinetic Energy and Peak Collision Force. This feature allows users the ability to customize these compatibility requirements.
- User-assignable Trajectory Simulation Convergence Criteria. This feature allows the user to set the number of attempted runs and the specific errors allowed for each path position.

The settings for these options are assigned in the new EDCRASH Calculation Options dialog; their current settings are displayed in the EDCRASH Program Data output report.

An interesting result of these new features is that users can now use EDCRASH to quickly and *graphically* set up a collision and calculate the results from a pure momentum analysis normally done on a hand-held calculator. Damage data need not be entered.

The Trajectory Simulation option has also been updated to use an unlimited number of friction zones.

## Rollover Simulation Update

In the Technical Session titled "Rollover Simulation" (see February 2001 newsletter), it was made clear that simulation of a rollover is not easy. One of the reasons identified was a technical problem related to the tire model calculation of radial deflection when the tire plane becomes nearly parallel with the ground plane.

Since publishing the last newsletter, we have studied the problem in great detail and are pleased to report that the code for tire radial deflection has now been redesigned to overcome this condition. This new design adds significant robustness to the application of the EDVSM model for rollover simulation.

## Technical Session

This Technical Session addresses the use of *HVE* for motorcycle crash reconstruction. As we made quite clear in the June 2000 Technical Newsletter (see *Newton on Motorcycles*), it is unwise to attempt a mathematical reconstruction of the collision phase of a vehicle vs. motorcycle collision – if your goal is to calculate the speed of the motorcycle. However, there is much that can be done in motorcycle crash reconstruction, and this Technical Newsletter tells you how to use *HVE* to perform such a reconstruction.

*HVE* includes a number of tools that can be used for studying the pre-impact and post-impact phases of a motorcycle vs. vehicle collision. In our example, we'll use *EDSMAC4*.

To perform the *EDSMAC4* analysis of the pre-impact phase, the general procedures are described below:

Start by adding the vehicles to the case. Use a movable barrier to model the motorcycle. Attach the *MCYamaha650.h3d* motorcycle geometry file to the movable barrier.

Change the default exterior dimensions to create a box the approximate size of the motorcycle. Change the default wheel locations such that the wheels are positioned correctly, using the wheels displayed in the geometry file as a guide. It is important to make the wheel y coordinates as small as possible, say +/- 0.5 inches for the right and left sides, respectively. This approximates a cycle-type vehicle. This approximation does not affect what we are attempting to show in our simulation of the pre-impact phase.

Next, add the *Freightliner* tractor and *Generic Class 4* trailer. Attach the *TLVdsTutorTrlr45Van.h3d* geometry file to the trailer.

Next, add the environment. In our example, we added one of the pre-defined intersection geometry files, *4T4\_Intersection.h3d*. Or, you can add your own, if desired.

Next, create an *EDSMAC4* event including the *Yamaha*, *Freightliner* and *Class 4 Generic* trailer.

Set up the event as you would normally, supplying the initial positions and velocities for the *Yamaha* and *Freightliner* (the trailer position and velocity are automatically assigned by *HVE* because it is attached to the tractor). Provide driver controls for

the *Yamaha* (we added pre-impact braking to illustrate the motorcycle driver's response to the tractor/trailer entering the intersection) and the *Freightliner* (we added steering and throttle as required to cause the tractor/trailer to pull out into the intersection and turn left).

Now execute the event. The figure below shows the sequence just before impact.

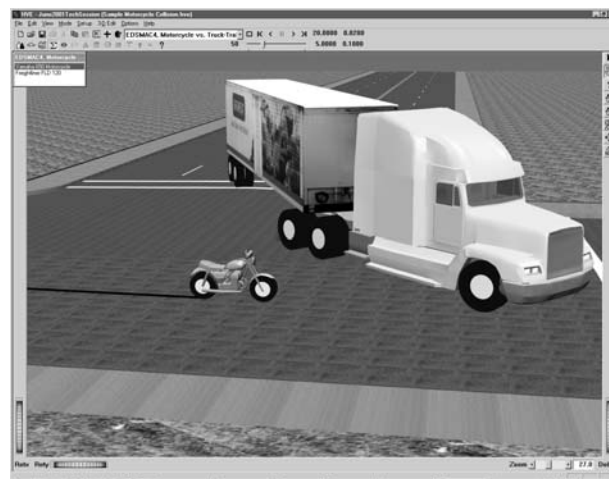


Figure 2: Screenshot of visualization of the pre-impact vehicle trajectories.

Because we used *EDSMAC4*, the motorcycle rider is not included in the event. This is easily remedied using an *EDGEN* event to model the rider (if we had used *SIMON*, we could have included the motorcycle rider directly in the same event!).

That's all there is to it. The above simulation is a simple, straight-forward application of *EDSMAC4* to simulate the pre-collision phase of the motorcycle collision. The key step was to create a motorcycle, starting with a *Generic Movable Barrier*.

Several additional things can be done to extend and/or enhance the simulation. For example, *EDGEN* can be used to simulate the post-impact phase. *EDGEN* can also be used to illustrate various trajectories for the motorcycle driver after impact. Of course, you can also produce several views of the simulation, first attaching the camera to the motorcycle and then attaching the camera to the truck tractor, to illustrate the view available to each driver.

If you would like to see our final result, check out the movies on our website at [www.edccorp.com/products/movies.html](http://www.edccorp.com/products/movies.html).

## Creating a New Vehicle

Let's say we need to reconstruct a crash involving a 1999 Mercedes E420. We find that *HVE* does not include the E420 in its custom vehicle database, so we decide to build one.

There are two ways to create a vehicle: One way is to find a similar vehicle and modify it. The other way is to start with a generic vehicle and modify it. Frankly, there is seldom enough similarity between unrelated vehicle models to justify starting with a "similar" vehicle. Thus, we normally suggest starting with a generic vehicle.

It is worthwhile to remember that *HVE* generic vehicles were developed from statistical analysis of similar vehicles within a vehicle type and size category. The procedure for developing the Generic vehicle database was described in SAE Paper No. 960897, "Updating the Vehicle Class Categories." By starting with a generic vehicle, whether it is a 2-D vehicle or a 3-D vehicle, you are assured that the entire set of vehicle properties will include sound estimates for the vehicle you are simulating.

Creating a new vehicle is easy. Just perform the following steps:

1. Choose the Vehicle Editor. The Vehicle Editor is displayed.
2. Choose *Add Vehicle, New*. The Vehicle Information dialog is displayed. This dialog provides access to the various vehicle databases (Generic.DB, EDC.DB, MyVehicles.DB, etc.).
3. Select the vehicle type. The options are *Passenger Car, Pickup, Sport-Utility, Van, Truck, Trailer, Dolly, Fixed Barrier, Movable Barrier*. Our Mercedes is a passenger car, and that's the default selection, so we don't need to do anything further.
4. Select the vehicle make. The first passenger car make in the vehicle database is displayed. Since we want a generic vehicle, click on the *Make* option list and choose *Generic*.
5. Select the *Model* and *Year*. Because a *Generic* make was selected, both the *Model* and *Year* fields already display *Generic*.
6. Select the *Body Style*. For Generic vehicles, this is where the Vehicle Class Categories reside. Choose the correct category according to wheelbase. The Mercedes E420 has a 111.5 inch wheelbase. From SAE 960897, Table 4-1, the

Mercedes E420 is a *Class 4 Passenger Car*, so select *Class 4* from the option list.

7. The remaining vehicle descriptors (*Number of Axles, Driver Location, Engine Location* and *Drive Axle*) are correct, so press *OK*. The Generic *Class 4 Passenger Car* is displayed in the Vehicle Editor.

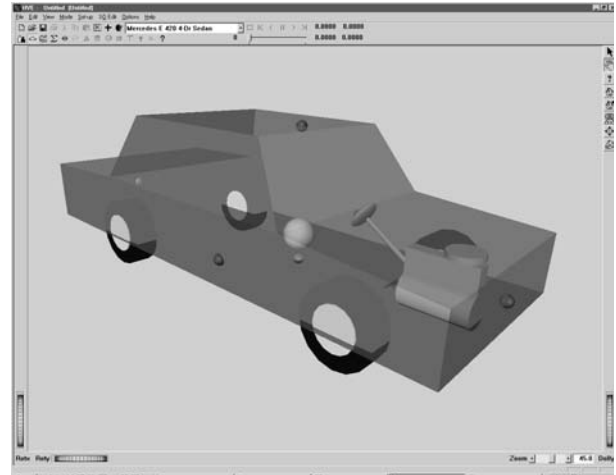


Figure 3: Generic body on Mercedes E420 4-Dr Sedan.

That's all there is to it. We now have a reasonable approximation of the 1999 Mercedes E420.

Of course, it is possible to edit the vehicle's generic parameters if they are known. The most common parameters are the vehicle total weight, exterior dimensions, wheelbase, trackwidth and stiffness coefficients. Most of these parameters are easily found from a variety of data sources – many you can measure yourself.

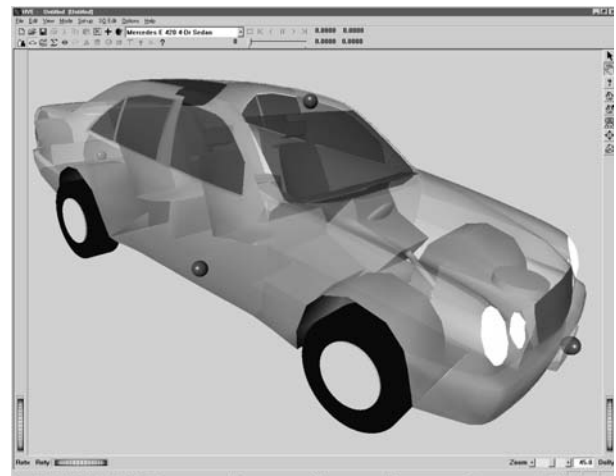


Figure 4: 3-D Model on Mercedes E420 4-Dr Sedan.

By default, the vehicle is displayed as a boxy approximation of a passenger car. If desired, *HVE* can display a 3-D model of the actual vehicle, as shown in Figure 4. This is done by obtaining a 3-D wireframe model (they are available from a variety of sources, including EDC) and attaching it to your vehicle.

The model of the 1999 Mercedes E 420 is now available for your current *HVE* case. But what about future cases? We can easily make it available to all future cases by adding it to our User database:

1. Click on the *Object Info* icon on the *HVE* toolbar. The Vehicle Information dialog is displayed, showing the attributes for the Generic Vehicle.
2. Choose *Save As*. The Vehicle Save As dialog is displayed.
3. Type in the *Make* (Mercedes), *Model* (E 420), *Year* (1996 – 2001; from Sisters and Clones List\*) and *Body Style* (4-Door Sedan).
4. Press *OK* to accept the vehicle database descriptors. The Vehicle Information dialog now displays the vehicle descriptors for the Mercedes E 420. Note also the Source Database is displayed as *user.DB*.
5. Press *OK* again to remove the Vehicle Information dialog. The Mercedes is now displayed in the Vehicle Editor.

The Mercedes is now selectable in the Vehicle Information dialog as well. Let's confirm this:

1. Choose *Add Vehicle, New*. The Vehicle Information dialog is displayed.
2. Select *Mercedes* as the vehicle Make. Note the *Model* (E 420), *Year* (1996–2001) and *Body Style* (4-Door Sedan) for the newly created vehicle are displayed. Note also the Source Database is *user.DB* – this is a database containing vehicles that you created.
3. Press *OK*. Your new Mercedes is displayed in the Vehicle Editor.

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\* EDC Library Reference No. 1057

## Importing Environment Files Into *HVE* Version 4

*HVE* Version 4 supports the use of VRML, Inventor or *HVE* format models directly, but requires the use of a translation program to prepare .3ds or other file types for use. The following guidelines are provided to help users import 3D terrain models built using AutoCAD or 3D Studio.

- When creating the model, use different layers and objects to keep groups separated. (E.g., roads, lane delineation, grass, sidewalks)
- Rotate the final model 180 degrees about the X axis.
- Scale the drawing to be in units of decimal inches.
- Export or save the model as a .3ds file format model. (This applies to both AutoCAD and 3D Studio users.)

There are advantages to saving as a .3ds file. Exporting the model as a .3ds file unifies the surface normals of faces to point in the positive Z direction (up in AutoCAD). Before the model is brought into *HVE*, these normals will need to be reversed to point properly in the negative Z direction (up in *HVE*). You can "invert" the faces using a program such as 3D Exploration available from [www.righthemisphre.com](http://www.righthemisphre.com).

- Translate the model from .3ds into .wrl (VRML 1.0) format using a translation program such as 3D Exploration. If using 3D Exploration, you must ensure that all default option boxes in the Save As dialog are unchecked before saving the model as a VRML 1.0 file. (I.e., Add indent, Lights, Cameras, Export Materials, Normals, Texture Coordinates and Polylines should be unchecked.)
- Copy the final .wrl format model into the *HVE*/supportFiles/images/environments directory.
- Open the model in *HVE*'s Environment Editor.

During the translation process from .3ds to VRML, the colors you used in 3D Studio or AutoCAD will be lost. You can use *HVE*'s 3-D Editor to re-assign colors and re-apply texture maps to objects in the model. Your model is now ready to drive on!

For more detailed instructions on creating and importing 3-D terrain models, please contact Technical Support.

## Tips on Making Simulation Movies with HVE Version 4 and HVE-2D Version 2

One of the benefits of HVE (and also HVE-2D version 2.0) is the ability to create an AVI (Video for Windows) simulation movie file of your results directly from the Playback Window. This feature allows the user to create a real-time movie that can be played back on a computer, or captured and recorded on video. Here are some important tips to remember when creating movie files.

1. *Select the best video codec (compressor/decompressor) suited to your requirements.* There are 3 possible choices at this time, that are typically available within the Windows operating system. (NOTE: Other codecs you may see listed may not be suitable for the 640 x 480 pixel format and the typical 16 or 32-bit color settings used in the HVE Playback Window.) These are: Full Frames (uncompressed), Microsoft Video 1, and Cinepak Codec. There are also suitable “aftermarket” codecs available from software vendors, such as TechSmith Screen Capture (TSSC) available from TechSmith at [www.techsmith.com](http://www.techsmith.com). Each codec has tradeoffs for quality, compression speed and file size, and some codecs have additional configuration or setting adjustments. Full Frames (uncompressed) is going to provide loss-less image quality, but recent testing with Microsoft Video 1 and TSSC have also proven to provide excellent image quality and with a smaller resultant file size. Below is a table highlighting some of the differences between movie files produced from HVE.

Table 1- Five second simulation movie with the camera view attached to the moving vehicle.

Video Compression (codec) option selected within HVE	File Size
Full Frames (uncompressed)	90.6 MB
Microsoft Video 1	25.8 MB
TechSmith Screen Capture	33.6 MB
Cinepak Codec	12.4 MB

Typically, the smaller the file size, the “smoother” the playback will appear. However, smaller may not always be better for image quality. You should experiment to determine which code to use.

2. *Consider using a “post-production” program to further compress the movie file size.* Typically, users are working with programs such as Adobe Premier or Camtasia Producer (TechSmith) to combine individual AVI files into one complete movie of their case work. These programs allow a user to use a codec to further reduce the file size generated during the production of the final movie file. Below is a table highlighting results from using Camtasia Producer to further compress a single AVI file.

Table 2 – Post-production file size results of high-quality 5 second simulation movie with a fixed camera.

Codec option selected within HVE	File Size	Codec used in Post-production	File Size
Full Frames	90.6 MB	MS Video 1	51.2 MB
Full Frames	90.6 MB	TSSC	1.0 MB
MS Video 1	25.8 MB	MS Video 1	2.0 MB
MS Video 1	25.8 MB	TSSC	0.9 MB
TSSC	33.6 MB	TSSC	1.1 MB

Table 3 – Post-production file size results of 5 second simulation movie file with moving camera.

Codec option selected within HVE	File Size	Codec used in Post-production	File Size
Full Frames	90.6 MB	MS Video 1	51.1 MB
Full Frames	90.6 MB	TSSC	21.4
MS Video 1	25.8 MB	MS Video 1	15.5 MB
MS Video 1	25.8 MB	TSSC	18.4 MB
TSSC	33.6 MB	TSSC	21.4 MB

As can be seen clearly from the tables, use of a post-production program can significantly reduce the file size, especially if your movie file is from a simulation using a fixed camera view. These smaller file sizes may help you produce your final presentation materials for your clients much easier. You will need to view the resultant movie file to be sure that you still have the image quality and playback smoothness that you require.

NOTE: One important discovery of note that is evident from our testing is that when a simulation movie is recorded using HVE v4.0, the same file size will be produced no matter if the camera is fixed or moving, if rendering is set from 1 to 10, or if anti-aliasing is set from 1 to 10. SGI version users may recall that the video file size was



affected by static or moving camera view, rendering and anti-alias settings.

There are also several programs available that allow you to record the "action" on a selected window or area of your desktop directly to a movie file. If you try to use one of these programs to capture a simulation movie being played either in the *HVE* Playback Window or in Windows Media Player, you may not be satisfied with the results. These screen capture programs may not be able to record as fast as the movie is played, thereby missing several frames which will cause the resulting movie to display very broken motion during playback.

A user should take a few moments and experiment with the different codecs available within *HVE* and determine which one is best suited for their requirements. If you have any questions, please contact technical support for more information.

Special thanks to Toby Frerich and Brian David Charles of Accident Reconstruction and Analysis in Corpus Christi, TX., for bringing the products available from TechSmith to our attention.

## Suggested Computer Requirements For *HVE* Version 4 and *HVE* Version 2

In our last newsletter, we provided recommendations for computer configurations that were suitable for running *HVE* v4. Since *HVE* and *HVE-2D* will now share the same code base, it is important that all users pay attention to the recommended **minimum** computer configurations below. The more your computer exceeds these minimum recommendations, the faster and more efficiently *HVE* and *HVE-2D* will run. This will ensure that you experience the best performance and trouble-free operation of your software.

### Minimum Configuration

- Intel Pentium II or similar processor  
(Intel Pentium III or IV preferred)
- 128MB RAM
- 9 GB harddrive
- 8MB Open GL-compatible graphics card

15" monitor (17" or 21" preferred)

2- or 3-button mouse (3-button preferred)

### Operating System

Windows 95, 98, Me, NT, 2000

If you have questions about specific models, please feel free to contact EDC Sales by phone at 503.644.4500 ext. 2, or by e-mail to sales@edccorp.com.

## Crashes Caused By Graphics Drivers

As a result of EDC's internal process of tracking and analyzing technical support calls, we have been able to clearly identify that some graphics card drivers do not support full graphics acceleration or performance boost settings for running engineering visualization programs such as *HVE* Version 4 and *HVE-2D* Version 2. Even though their graphics cards/computers are relatively new and identified as OpenGL compliant, some users have reported experiencing crashes of the program, especially when displaying highly-detailed, highly-texture mapped environment models. If you experience this behavior, follow the steps below to work-around and/or permanently fix your graphics driver problem:

### Work-Around

- Reduce your Hardware Acceleration (95, 98 Me), Performance Boost (NT) or Troubleshooting (2000) setting down to None.

### Permanent Solution

- Contact the vendor for your computer or graphics card to determine if an updated graphics driver is available. Users that have downloaded the latest graphics driver have often been able to return their settings to Full once again. This is especially true for nVIDIA and ATI Rage Mobility graphics card drivers.

Even if you recently purchased a brand new computer, you may find that an updated graphics driver is available. It can often take several months for the production configuration of the computer to be updated, so don't overlook the possibility that a new graphics driver may have been released since the configuration of your computer was established.

## Technical Support FAQ

We are frequently asked about the meaning of the A, B, and  $K_v$  stiffness coefficients used in the HVE-compatible programs *EDCRASH*, *EDSMAC*, and *EDSMAC4*. Both the CRASH and SMAC collision algorithms use vehicle crush stiffness coefficients that are derived from vehicle-to-barrier crash data. Following are descriptions of the methods for calculating the two sets of coefficients from fixed, rigid barrier crash test data. Crush stiffness coefficients can also be calculated from moving, rigid barrier crash test data, but the computations are more involved (see Vehicle Crush Stiffness Coefficients, EDC Library Reference No. 1042).

As you will see, you cannot convert directly from A and B to  $K_v$  without using details from the crash test data.

### Fixed, Rigid Barrier Crash Test

- $W$  = test Weight (lb)  
 $V$  = test Speed (in/sec)  
 $C_{avg}$  = average Crush depth (in)  
 $L$  = crush Length (in)  
 $b_0$  = threshold "no damage" test speed (in/sec)  
 $b_1$  = speed to cause 1 inch of crush (in/sec/in)  
 $g$  = acceleration due to gravity (in/sec<sup>2</sup>)

First, calculate  $C_{avg}$  as in Figure 5.

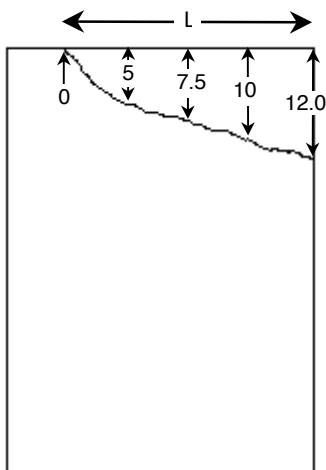


Figure 5: Vehicle with measured crush depths (in).

$$C_{avg} = \frac{0+5+7.5+10+12.5}{5}$$

$$C_{avg} = 7.0 \text{ inches}$$

### CRASH and EDSMAC4 Collision Algorithms

The *EDCRASH* and *EDSMAC4* collision algorithms use A and B stiffness coefficients, defined below and in Figure 6. Using these two coefficients, Force and Crush are linearly related.

- A = force required to initiate crush (per unit width) (lb/in)  
 B = spring rate (per unit width) (lb/in<sup>2</sup>)

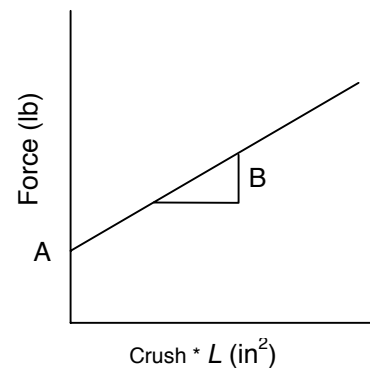


Figure 6: A and B stiffness coefficient definitions.

The process for calculating A and B is described below.

- (1) Assume  $b_0 = 5 \text{ mph} = 88 \text{ in/sec}$  (for a 5 mph bumper)
- (2)  $b_1 = \frac{V - b_0}{C_{avg}}$  (assumes rebound velocity = 0)
- (3)  $A = \frac{W b_0 b_1}{g L}$
- (4)  $B = \frac{W b_1^2}{g L}$

### SMAC Collision Algorithm

The *EDSMAC* collision algorithm uses a single stiffness coefficient,  $K_v$ , defined below and in Figure 7. Using this one coefficient, Force and Crush are linearly related, as in the *EDCRASH* and *EDSMAC4* collision algorithms, but now the curve

of Force vs. Crush passes through (0,0). This means that *any* force will result in crush.

$K_v$  = spring rate (per unit width) (lb/in<sup>2</sup>)

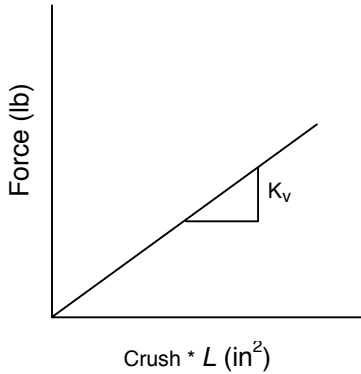


Figure 7:  $K_v$  stiffness coefficient definition.

The process for calculating  $K_v$  is described below.

- (1) Assume  $b_0 = 0$  mph = 0 in/sec (essentially a 0 mph bumper)

(2) 
$$b_1 = \frac{V}{C_{avg}}$$

(3) 
$$K_v = \frac{W}{g} \frac{b_1^2}{L}$$

For simulations in which the closing velocity is less than the test speed, SMAC over predicts crush, but

➤ GETS THE FORCE CORRECT! (Figure 8).

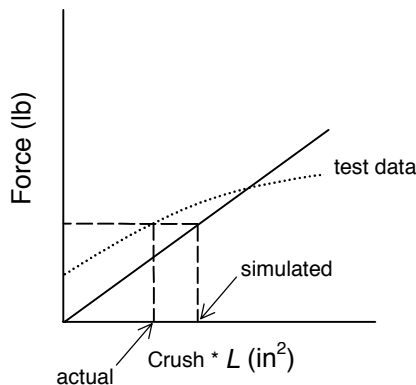


Figure 8: Comparison of actual to modeled vehicle crushes and crush stiffness using the  $K_v$  stiffness coefficient.

## HVE User's Group Top 10 Wish List

The following are the "Top 10" most requested features to be added to HVE as voted by HVE users at the 2001 HVE Forum:

1. Extend the vehicle database
1. Translators for environment models from AutoCAD or other format to HVE format
2. Antilock brake modeling (Yaw Control)
3. Tire model that addresses sidewall contact with terrain/curbs
4. Extended suspension model/air suspension for trucks
5. Human models selected by height and weight
6. Display key results in playback window
7. Dynamic payload shift
7. Inherit initial conditions from other event
8. Attach camera view to follow target
9. Visual appearance of headlights on vehicle during nighttime simulations
9. Brake table dependent (selectable) brake lights
10. Customizable toolbar
10. Visualize fifth wheel and kingpin locations

## Tech Support Hints and Tips

- In order to simulate a failed brake system in HVE, click on the failed vehicle wheel(s), choose *Brake*, and set the Brake Torque Ratio equal to 0.0
- The Event Controller contains both *Reset* and *Rewind to Beginning* buttons, that may, at first, appear the same, but are, in fact, quite different.

**Reset**



**Rewind to Beginning**

After executing an event, pressing the *Rewind to Beginning* button causes the humans and vehicles to return to their initial positions. Notice that the *Reset*, *Execute*, and *Advance to End* buttons are all selectable. By contrast, while pressing the *Reset* button causes the humans and vehicles to return to their initial positions, it also causes the output tracks (results) to be erased. After pushing *Reset*, only the *Execute* button is selectable and no output is available in the Playback Editor.

## Call for Papers

Those interested in presenting a technical paper in the "HVE White Paper" session for the 2002 HVE Forum are invited to submit an abstract for consideration. This session is an opportunity for you to showcase your skills to other HVE users as well as to non-HVE users who may wish to hire you as a consultant.

Please submit your abstract, of 100 to 250 words in length, to EDC Customer Service before October 15, 2002. 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 feel free to call.

## Training Courses

### Vehicle Dynamics

Theoretical and Applied Vehicle Dynamics extends the theory of the SAE course and includes direct applications using the HVE three-dimensional simulation environment as well as a solid theoretical background for such simulations. The course is focused toward those with an advanced interest in vehicle dynamics, accident reconstruction and simulation.

### EDC Reconstruction & EDC Simulation

EDC provides excellent 1-week training courses on the use of EDC Reconstruction or Simulation software. Even long-time users agree that the courses are extremely beneficial and challenging.

The courses are designed to investigate fully the

#### Engineering Dynamics Corporation Training Courses

##### EDC Simulations

Los Angeles, CA.....January, 2003  
Coral Gables, FL.....November 13-17, 2001

##### EDC Reconstruction

Los Angeles, CA.....January 21-25, 2002  
Coral Gables, FL..... November 11-15, 2002

Theoretical and Applied Vehicle Dynamics  
Central United States.....Fall, 2001

##### 2002 HVE Forum

New Orleans, LA.....May 13-17, 2002

program's inner workings. Lectures are full of helpful hints gained from years of experience.

### HVE Forum

The HVE Forum is an excellent opportunity for HVE, HVE-2D and EDVAP users to jump to a new level of ability. By participating in workshops and special lectures, attendees can brush up on their present skills, learn new techniques of applying simulation modeling, 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 and information.

### Course Registration

Our courses are often full, so be sure to register early to avoid missing out! You may register for a course simply by contacting EDC Customer Service at 503.644.4500, or by sending an email to [training@edccorp.com](mailto:training@edccorp.com). We look forward to seeing you at our next course!

### NUCPS Training

NUCPS (previously NUTI) offers four different courses using EDVAP and/or HVE-2D. For more information about the courses and registration, please contact NUCPS at 800.323.4011.

#### Northwestern University Center for Public Safety Training Courses MATAR (EDCRASH)

Evanston, IL .....September 24-28, 2001

#### COMPTAR I (EDCRASH)

Evanston, IL .....September 17-21, 2001

#### COMPTAR III (EDSMAC)

Evanston, IL .....October 1-5, 2001

#### COMPTAR IV (EDCRASH & EDSMAC Extended)

Evanston, IL ..... Call for dates

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