

Technical Newsletter

Available on-line in the EDC Library at www.edccorp.com

Viva Las Vegas!

There will be no Elvis impersonators at the 2019 *HVE* Forum in Las Vegas during the week of February 25th. Instead there will be over 30 workshops focusing on learning the inner workings of *HVE* and *HVE-2D*. Workshops are targeted at every user level, from beginner to advanced. There are also User's Group meetings and the *HVE* White Paper Session.

The Forum has not been in Las Vegas since 2003, and this year's venue couldn't be better: the famous Tropicana, located right on Las Vegas Blvd., A.K.A., *The Strip*.

For workshop information and to register, go to edccorp.com/2019HVEForum or call 888-768-6218. We are happy to discuss the workshop options with you to select the workshops that maximize your week of learning.

Having just completed the week of training at the EDC Simulations class last week, it is interesting to compare the culture of the EDC Reconstruction and Simulations classes with the culture of the *HVE* Forum. The EDC Reconstruction and Simulations classes are, in a word, intense. There are homework and review questions each night. Students often fill an entire yellow pad with notes. There's even a 2-hour test at the end of the week. But students don't seem to mind. In fact, student evaluations routinely claim it was the best learning experience since finishing their college degree.

On the other hand, the culture of the *HVE* Forum is laid back. No homework or review questions. No test. Students often bring their spouse. And yet, the learning experience at the Forum garners the same excellent reviews as the Reconstruction and Simulation classes.

Issue with Brake Table

HVE 2018 Service Pack 1 (see below) corrects an issue with the Brake Table Wheel Force and % Available Friction options: The entries for the right side and left side are swapped. This will affect any event using these options if there is unequal side-to-side braking. Please be sure to download and install Service Pack 1 and confirm your results. We deeply apologize for the error. This issue does not affect events using the Steering or Throttle Tables or Brake Tables using the Pedal Force option.

JACKPOT!

2019 HVE FORUM

WORKSHOPS

- Advanced HVE
- Advanced HVE-2D
- EDCRASH, EDSMAC4, EDSVS and EDVTS Overview
- Advanced Multi-vehicle Simulation Using SIMON
- Theoretical and Applied Vehicle Dynamics
- Multi-vehicle Collisions Using EDSMAC4
- Building Vehicles for HVE and HVE-2D
- HVE and HVE-2D User's Groups
- Powerful Tips and Techniques Using DamageStudio
- Hydroplaning Simulation
- HVE White Paper Session
- Tractor-Trailer and Commercial Vehicle Simulation
- Simulating Curbs, Potholes and Soft Soils
- Brake System, ABS and ESC Simulation
- Simulating Blow-outs and Rollovers
- DyMESH 3-D Collision Model
- Creating Advanced Terrains
- Introduction to HVE-CSI
- High-Definition Video Output

February 25 To March 1, 2019

Tropicana Las Vegas

EDC
ENGINEERING DYNAMICS CORPORATION

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Animation

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HVE 2018 Service Pack 1

HVE 2018 was introduced on October 8, 2018, and Service Pack 1 was made available on December 19. Service Pack 1 corrects several important issues with table input (e.g., Driver Steering, Throttle and Braking), an issue with Intel Integrated Graphics cards and reading of certain older version vehicles and case files. Other issues are currently being addressed; Service Pack 2 is expected to be available in about one month.

To update your software, go to the Support->Downloads section of edccorp.com. Service Pack 1 does not require a new license.

Technical Session

Our Technical Session this time deals with the detailed interaction between a vehicle tire and the terrain. This subject is, of course, extremely important because, in the absence of a collision, nearly all the forces that determine the motion of a vehicle occur at the tire-terrain interface.

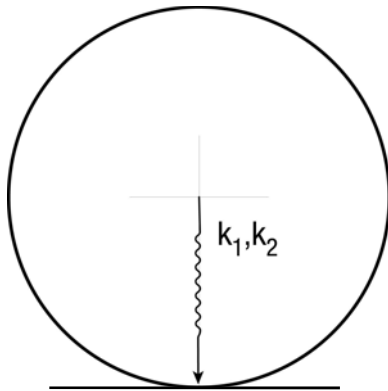


Figure 1 - Point Contact Tire-Terrain Model. This model uses GetSurfaceInfo() to identify a single contact point on the surface beneath the wheel center.

Consider a tire on a flat surface, as shown schematically in Figure 1. The exact vehicle-fixed x,y coordinates for the point on the surface can be calculated based on the coordinates of the wheel center, adjusted for wheel steer and camber angle. This method of identifying the point on the surface is called the Point Contact Tire-Terrain Model. The earth-fixed X,Y coordinates for this surface location can be calculated using the same wheel center coordinates, steer and camber angle, and the vehicle's current earth-fixed CG location and orientation.

Let's look a little closer at that flat surface. It might be a single polygon with three corners (i.e., a triangle). But it could also be a surface composed of thousands of triangles representing the road surface, the pavement stripes, the shoulder and the adjacent terrain. Each of these triangles may have different friction factors (multipliers) that affect the current peak and slide friction coefficients between the tire and the terrain.

GetSurfaceInfo()

HVE has a library of functions available to developers of vehicle dynamics programs (collectively, this library is referred to as the HVE Developer's Toolkit). GetSurfaceInfo() is one of these functions. GetSurfaceInfo() is inserted into the vehicle dynamics program's tire model. Its purpose is simple: Given the tire's current earth-fixed X,Y coordinates, find the triangle directly beneath those coordinates, then return to the tire model the earth-fixed elevation, Z, of the contact point on the triangle, as well as the triangle's surface normal, \vec{N} , and friction multiplier, f. The current tire deflection is simply the difference between the surface elevation, Z, and the elevation of the contact point of an undeflected tire.

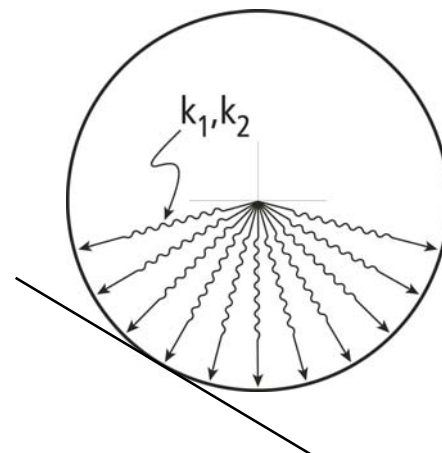


Figure 2 - Radial Spring Tire-Terrain Model. This model uses GetTerrainInfo() to identify a series of potential contact points with the surface on the tire perimeter.

Now let's consider a tire on a sloped surface, as shown in Figure 2. In this case, it's not possible to directly calculate from the wheel position along the earth-fixed X,Y coordinates of the point of contact between the tire and the terrain. The solution is to test a series of points on the tire's perimeter and identify those points on the undeformed perimeter that lie below the surface. But we now have an additional complication: The tire's contact point(s) may no longer lie directly below the wheel center earth-fixed X,Y coordinates, as assumed by GetSurfaceInfo().

GetTerrainInfo()

The *HVE* Developer's Toolkit includes another function, called `GetTerrainInfo()`, which is similar to `GetSurfaceInfo()`, with one big difference: Instead of looking straight down the earth-fixed Z axis for surfaces, `GetTerrainInfo()` can look in any direction. The Radial Spring Tire-Terrain Model establishes a series of vectors representing spring elements that lie in the tire plane and project radially from the wheel center towards the tire's perimeter. The earth-fixed direction of each vector can be calculated from the wheel center coordinates and tire plane orientation. Thus, the point where the vector penetrates the terrain can be calculated. The tire is in contact with the surface (and the spring is compressed) if the distance from the wheel center to the point of surface penetration is less than the unloaded tire radius.

Figure 2 shows that there are several equally spaced spring elements (typically between 10 and 25), and each spring must be tested for penetration with the surface to establish the X,Y,Z coordinates of the penetration point. Thus, calculation times can be roughly 10 to 25 times longer, maybe even longer (more on that later).

Because it uses `GetTerrainInfo()`, the Radial Spring Tire-Terrain Model is useful for complex terrains, such as those with potholes and curbs; actually any terrain with severely sloped surfaces.

Polygon Type and Hierarchy

Each terrain polygon has a *Type* attribute. The *Type* attribute for the selected polygon is displayed and may be changed in the 3-D Editor. The polygon's *Type* determines its hierarchy. From highest to lowest, the options are:

- Water
- Curb
- Friction Zone
- Road
- Other

Keep reading to discover just how important the *Type* attribute really is.

Searching the Polygon Database

The terrain is composed of a list of triangles, each one containing geometric, friction and material properties, in addition to the *Type* attribute. This list of triangles and their data is referred to as the Polygon Database. A

basic flat surface might contain less than 10 triangles. However, a terrain built from a total station survey may contain several thousand; and a terrain built from a point cloud scan may contain a virtually unlimited number of triangles (i.e., millions!). The memory required to store the information for each triangle can be several gigabytes. Although *HVE* 2018's new 64-bit architecture allows it store this information, using that information can be another matter.

Remembering that `GetSurfaceInfo()` or `GetTerrainInfo()` is executed for each tire at each and every integration timestep, it becomes obvious that, as a vehicle travels along the terrain, it takes even the fastest computer some time to locate in the Polygon Database the triangle over which the tire is currently traveling. The search through the Polygon Database is directly affected by the *hierarchy* of the *Type* attribute: *Water* polygons are searched first (required by the Hydroplaning Model), then *Curb* polygons (identifying these greatly speeds up the Sidewall Impact tire-terrain option), then *Friction Zone* polygons (allows the user to place a region with different friction over the top of an existing road surface), then *Road* polygons (typically the default). Note that *Other* polygons are not searched at all. This attribute is are very useful for surfaces over which a vehicle will never travel. Assigning *Other* polygons can greatly reduce the overall size of the Polygon Database that needs to be searched.

But there are some ways to make the search more efficient. Each method has its advantages and drawbacks. The methods available in *HVE* are:

From First Polygon – This method simply starts with the first polygon in the database and continues, polygon by polygon, until the required triangle is found. Hierarchy is always obeyed. This is the slowest method.

From Previous Polygon – This method looks first at the triangle that was beneath the tire during the previous timestep. If that triangle is not the required triangle, the search continues, searching through the polygon database alternating in both directions until the required triangle is found. Note that this method may not take advantage of the polygon hierarchy: If the previous triangle had a *Road* attribute, the hierarchy of a *Friction Zone* polygon will be ignored. This is the fastest method.

From Previous Polygon, Sorted – This method restores the hierarchy to the *From Previous Polygon* method. If the previous polygon is not beneath the tire, the search starts over in groups according to the *Type* attribute hierarchy. This method is significantly

faster than the From First Polygon method, but not as fast as the *From Previous Polygon* method. *From Previous Polygon, Sorted* is the default method.

The *Search Method* is selected in the Event Editor by choosing Options->GetSurfaceInfo.

An observation: GetSurfaceInfo() or GetTerrainInfo() will end up searching the entire polygon database if fails to hit a triangle. This has two performance implications:

- As a vehicle drives off of the terrain (i.e., there is no surface below the tires), execution will slow down considerably, especially for a complex terrain with many polygons.
- If the Radial Spring Tire-Terrain Model is used for a relatively flat terrain, setting the Angular Span to +/- 90 degrees will result in slow execution because the search for spring elements at exactly +90 and -90 are approximately parallel to the terrain and are unlikely to hit a triangle. This suggests it is a good idea to set the Angular Span to the minimum angle that accomplishes the desired task, i.e., finds the required tire-terrain interaction. For example, the minimum Angular Span, Θ , for a curb impact can be estimated from the curb height, h , and the tire's unloaded radius, R_u , as shown in Figure 3.

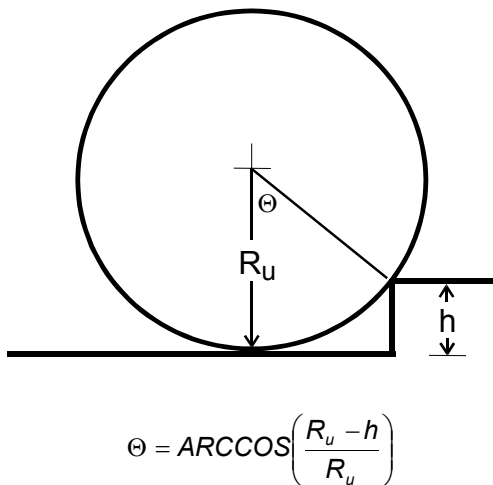


Figure 3 - Calculating the minimum required Angular Span value for a curb impact..

To learn more on this important topic, attend the 3-D Editor Workshop at the *HVE* Forum.

EDC Simulations November 4 - 8, 2019 Miami, FL

EDC Simulations is an extensive one-week training seminar that offers an excellent way to learn the inner workings of *EDSMAC*, *EDSMAC4*, *EDSVS* and *EDVTS*. The course focuses on the physics models, the calculations and the underlying assumptions for each of the programs' major calculation procedures.

EDC Simulations is designed to be like a college physics course - a combination of morning lectures and afternoon hands-on lab exercises. The fact that this course has been presented annually for over 25 years ensures that students benefit from a well designed and well executed week of instruction.

EDC Simulations has been pre-approved for 30 ACTAR CEUs. All course materials, including a handbook, training manual, software and temporary licenses, are provided to each student.

Bring your scientific calculator and laptop computer. Four lab exercises include loss-of-control simulations, parametric studies, collision simulations and setting up the pre-impact phase of a 15-second crash sequence.

Links to download your course registration form and to make your hotel reservations at the Hampton Inn Dadeland, Miami, FL, are available on the EDC Simulations page in the Training section of edccorp.com. Contact EDC at 888.768.6216 to sign up today!

EDC is Again Building Vehicles

As of January 1, EDC is back in the business of building vehicles. As a result, EDC and Vehiclemetrics databases will be sold and maintained separately. This is expected to increase the total number of vehicles available to *HVE* and *HVE-2D* users.

We have redesigned our internal systems, resulting in a significant efficiency increase. Service Pack 2, expected out in about one month, will have the new vehicles shown in the table below.

Table 1: New Vehicles

YEAR RANGE	VEHICLE
2018	Toyota Camry SE 4-Dr Sedan
2015 - 2018	Honda Fit EX-L 5-Dr Hatchback
2018	Honda Accord Touring 4-Dr Sedan
2015 - 2018	Honda HR-V EX-L SUV
2012 - 2018	Ford Focus 5-Dr Hatchback
2013 - 2018	Ford Escape SE SUV



We are adding about one new vehicle every two weeks, so we expect to add 20 to 25 new vehicles in 2019. As they are added, these new vehicles will be made available in each software update and service pack release.

As of January 1, 2019, Vehiclemetrics is taking over sales and support of their vehicle database (but please feel free to contact EDC Technical Support for any questions about *HVE* events that include Vehiclemetrics vehicles). They continue to be a very good source for quality vehicle models for *HVE* and *HVE-2D* users. You can contact Vehiclemetrics at www.Vehiclemetrics.com or call 855-966-3357. They are located in Windsor, Ontario, Canada.

Past Technical Sessions

Each Newsletter includes a Technical Session that focuses on a single technical subject of importance to *HVE* users. For example, this Newsletter's Technical Session (see Page 2) describes the methods used by *HVE* to model the interaction between a vehicle's tires and the terrain. A partial list of prior Technical Sessions is shown in Table 2. These may be accessed at www.edccorp.com, click on Library->Newsletters.

HVE Partners Program

Are you aware of the *HVE* Partners Program? You should be! EDC receives numerous requests for referrals of qualified *HVE* users to help industry clients (usually attorneys), as well as other *HVE* users seeking specialized assistance. That makes sense because broadly speaking, *HVE* users are the cream of the crop when it comes to knowledgeable consultants in the accident reconstruction industry.

Table 2: Past History of Technical Sessions

ISSUE	SUBJECT
Summer 2018	Degrees of Freedom
Summer 2017	Introducing the New <i>HVE</i> Brake System Model
Fall 2016	New Thermodynamics Model for Disc Brakes
Spring 2016	<i>HVE</i> 's New Post-Impact Path Definition Options
Summer 2015	An Overview of the <i>HVE</i> Vehicle Model Data Set
Spring 2015	Using the Traffic Signals Simulation System in <i>HVE</i>
Winter 2015	Backgrounder and Tutorial for the <i>HVE</i> DyMESH Wheel Impact Model for Solid Axle Suspensions
Fall 2014	<i>HVE</i> DyMESH Wheel Impact Model Backgrounder and Tutorial
Summer 2014	Backgrounder for Vehicle Performance Testing
Winter 2014	Backgrounder for the New <i>HVE</i> Vehicle Light System
Summer 2013	<i>HVE</i> Drivetrain Model % Available Friction Inputs
Spring 2013	Combining Events Using the <i>HVE</i> Video Creator
Winter 2013	Detailed Overview of <i>HVE</i> 's Damage Profile Dialog
Fall 2012	Trailer Separation Model - Backgrounder and Tutorial
Summer 2012	<i>HVE</i> Driver Model Tutorial
Spring 2012	Curb-Tripped Rollover Simulation
Winter 2012	Tutorial Using DamageStudio for EDSMAC4

Consultants in the *HVE* Partners Program are listed on the EDC website, www.edccorp.com. Click on Partners to navigate to the list of *HVE* Partners, as well as Vehicle & Environment modeling Partners and Training Partners.

To be included in the *HVE* Partners Program, send an email to EDC Customer Service (info@edccorp.com) and we'll send you the questionnaire to fill out. The requested information includes company information, area(s) of specialization, years of experience and regional/geographical coverage.

Become a member of an elite list of consultants. We look forward to adding you to the list!

File Export

One of the lesser known *HVE* features is the ability to export a pre-defined set of output variables using the File, Export feature. Most users are familiar with using Copy/Paste from the Variable Output table to, say, a spreadsheet. And that works well for one-off situations. For example, you may want to create a graph of position, velocity and acceleration vs. time. (This cannot be done using *HVE*'s Variable Output graphing utility because it requires that all dependent variables have the same units.)

But you may have a recurring work flow situation where you need to output the same variables for an animation program, such as 3D Studio. In that case, you need six position variables for the sprung mass and six position variables for each wheel (assuming you want to visualize the detailed motion of each wheel). Selecting all of these variables can be time-consuming. Wouldn't it be nice if you could create a short-cut that you could reuse the next time you want to select the same variables? That's exactly what the File, Export option does.

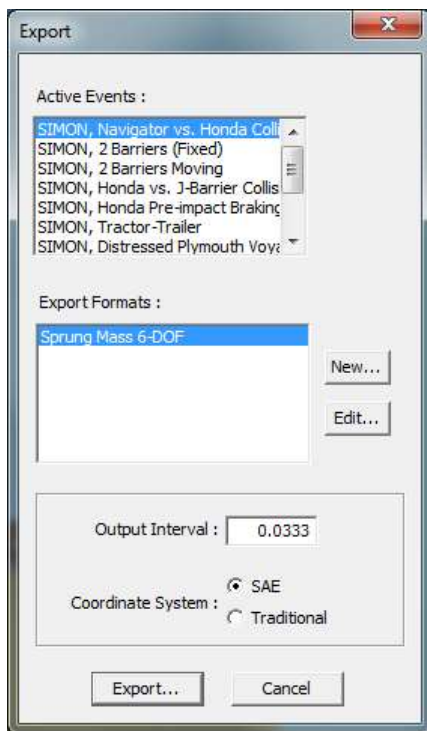


Figure 1 - The Export dialog allows the user to select a simulation event and output the selected simulation results in the desired format.

When you choose File, Export, a dialog is displayed that lists all the simulation events in the case, as shown in Figure 1. A second listbox displays a list of all the available pre-defined Export Formats that define the individual output variables. Notice that you can create new formats and edit existing formats. A new format is created by selecting variables using the same Variable Selection dialog you use for selecting Key Results or Variable Output (see Figure 2). These individual formats can be stored for later use. The next time you need to output simulation results for your animation program, simply choose the desired format from the Export Formats list.

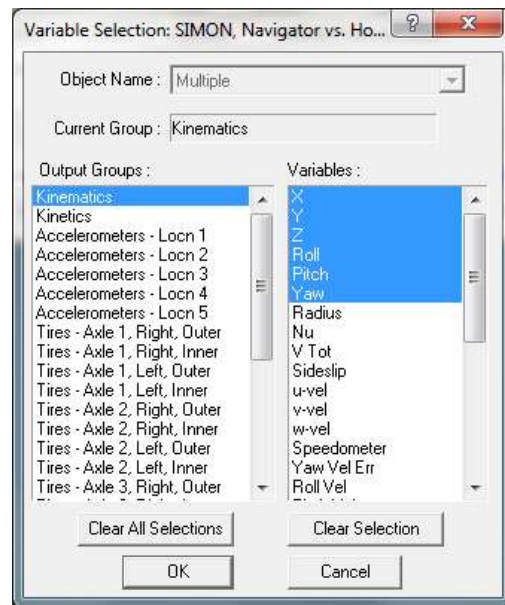


Figure 2 - The Variable Selection dialog is used for selecting the desired output variables. This is the same dialog used for selecting Key Results and Variable Output variables.

After selecting the desired export format, you assign the output interval (the current Playback Interval is the default). Finally, choose the desired coordinate system; you can output coordinate data in either the default SAE coordinate system or the more traditional coordinate system (Z direction up) used by most animation programs.

Export produces a comma-delimited file that can be pasted directly into your program. If your normal workflow involves exporting simulation results to a third-party application, this is a very convenient feature!

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

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

Q: When I try to launch HVE an error message appears and HVE never opens. The error message states 'Bad or missing VCOMP140.dll, VCOMP120.dll or MFC120.dll'.

A: Some computers are shipped without a set of required runtime libraries.

If you are running a 32-bit version of HVE (HVE 2017 and older), navigate to Microsoft's website to download and install the "Microsoft Visual C++ 2013 Update 5 Redistributable Package". It's important to download the 2013 version which can be accessed via this link: <https://support.microsoft.com/en-us/help/3179560/update-for-visual-c-2013-and-visual-c-redistributable-package>. Once there, scroll down to the 2nd table of links titled "x86.exe File Path" and click on the *English – United States* link and then click *Run* to install the DLL package.

If you are running HVE 2018 which is a 64-bit program, you'll need to select this link: http://download.microsoft.com/download/0/5/6/056DCDA9-D667-4E27-8001-8A0C6971D6B1/vcredist_x64.exe, or copy and paste it into your preferred Internet browser. The link will trigger the download of the necessary update for Visual C++ 2013 and the Visual C++ Redistributable Package. Once downloaded please double click the "vcredist_x64.exe" to trigger the installation process. Once the installation is complete please restart your computer and then try to launch HVE again. At this point HVE should launch successfully but if it doesn't please give us a call at 503-644-4500 or 888-768-6216.

Q: How do I import Point Cloud Environments?

A: A point cloud environment is imported just like any other environment, but the points must first be meshed for the physics' tire model to find the surface. The Faro SCENE program does this. Here's a link to a Faro tutorial describing the process: <https://www.youtube.com/watch?v=kqJUJXLf5MI>.

The process allows you to set the maximum number of triangles. To create reasonable runtimes, this should be set at or below 100,000 (read the Technical Session to see what happens if you don't reduce the number of

triangles). You can export the meshed surface in a VRML or OBJ format.

EDC is also working on a set of tools to "smartly" automate the triangle reduction process (removing co-planar triangles, while keeping important elevation changes associated with potholes, curbs, etc. Unfortunately, our mathematician working on that project has had a family emergency and has been off work. That has set back the introduction of those tools.

We have been working directly with Faro, so we're familiar with their methods. If you are using a scanner other than Faro, other companies have post-processing software for their scanners that accomplishes the same tasks.

Q: Ever since I updated to HVE 2018 my environment and events appear much darker, what's going on?

A: The default light source is the sun, the location of which is set in the Environment Editor. Unfortunately HVE 2018 has a bug that causes the sun's light source to turn off. The work-around is to right-click in the viewer and select the *Headlight* option in the pop-up menu. The headlight is a light source that is attached to the viewer's camera so it will always illuminate what's in the viewer. We hope to have the issue resolved in Service Pack 2.

Q: HVE crashed while I was working on an event and I haven't saved my work for several hours. Help! Is everything lost? Does HVE have an Auto Backup feature?

A: Yes! You can select the desired settings for Auto Backup by choosing User Preferences from the Options menu. The backup case file is saved in the Temp folder located in your HVE or HVE-2D installation directory. An Autosave prefix is added to the file name along with the date and time of the crash. Remove this prefix when you save the file. If you have trouble locating your Temp folder, please call EDC Technical Support at 888-768-6216.

Q: Can SIMON simulate a locked or limited slip differential?

A: No. SIMON models only drivetrains with an open differential.

Visit the Support section of www.edccorp.com to download software updates and to view more FAQs from the Knowledge Base.

EDC Training Courses

EDC Reconstruction & Simulations

EDC offers excellent one-week courses on the use of the *EDCRASH* reconstruction program and the *EDSMAC*, *EDSMAC4*, *EDSVS* and *EDVTS* simulation programs. The **EDC Reconstruction** and **EDC Simulations** courses are designed to fully investigate the inner workings of these *HVE*-compatible physics programs. Lectures are full of helpful hints gained from years of experience. During the course, students will use the physics programs to complete several lab exercises highlighting the capabilities of each program discussed in the course.

All users of *HVE* and *HVE-2D* agree that these courses are extremely beneficial and challenging. It's the fastest way to learn what you really need to know – how to effectively use the physics programs and get the right results. *Note: These courses focus on the physics programs, not on the HVE user interface.* For courses that focus on the *HVE*, *HVE-2D* or *HVE-CSI* user interface, check out the workshops at the *HVE* Forum.

HVE Forum

The **HVE Forum** offers over 30 workshops designed to help *HVE*, *HVE-2D* and *HVE-CSI* users improve their modeling and application skills. By participating in workshops, attendees learn new techniques and also how to use the latest advancements in the software. The *HVE* Forum is also a great opportunity to meet other users and expand your network of resources.

Engineering Dynamics Corporation Training Course Schedule

EDC Reconstruction

Los Angeles, CA January, 2020
Miami, FL November, 2020

EDC Simulations

Miami, FL November 4 - 8, 2019
Los Angeles, CA January, 2021

Theoretical & Applied Vehicle Dynamics

Upon Request

2019 HVE Forum

Las Vegas, NV Feb 25 - Mar 1, 2019

Vehicle Dynamics

The **Theoretical & Applied Vehicle Dynamics** course extends the scope of a general vehicle dynamics discussion by including several direct applications using the *SIMON* vehicle dynamics simulation program within *HVE* and providing a solid theoretical background for such simulations. The course is focused towards engineers and safety researchers with an interest in an understanding of vehicle dynamics and automotive chassis systems development.

Course Registration

To register for a course, download a registration form from the Training page at edccorp.com or contact EDC Customer Service at 888-768-6216 or by email at training@edccorp.com. All courses are eligible for Continuing Education Units and ACTAR credits.

HVE Training Partners

HVE, *HVE-2D* and *HVE-CSI* users looking to improve their skills, but unable to attend one of EDC's regularly scheduled courses, can contact an *HVE* Training Partner for assistance. *HVE* Training Partners are experienced *HVE* and *HVE-2D* users who offer introductory and custom training courses on the use of *HVE*, *HVE-2D*, *HVE-CSI* and *HVE*-compatible physics programs. The list of *HVE* Training Partners may be found at www.edccorp.com.

HVE Discussion Groups

Websites hosted by experienced *HVE* Users offer information about using *HVE* as well as moderated online discussions with other users. Be sure to visit:

AccidentReconOnline.com - Online training courses and also the DiscoverHVE video tutorials and discussion group hosted by Wes Grimes of Collision Engineering Associates.

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