SPRING 2012 ENGINEERING DYNAMICS CORPORATION

# Technical Newsletter

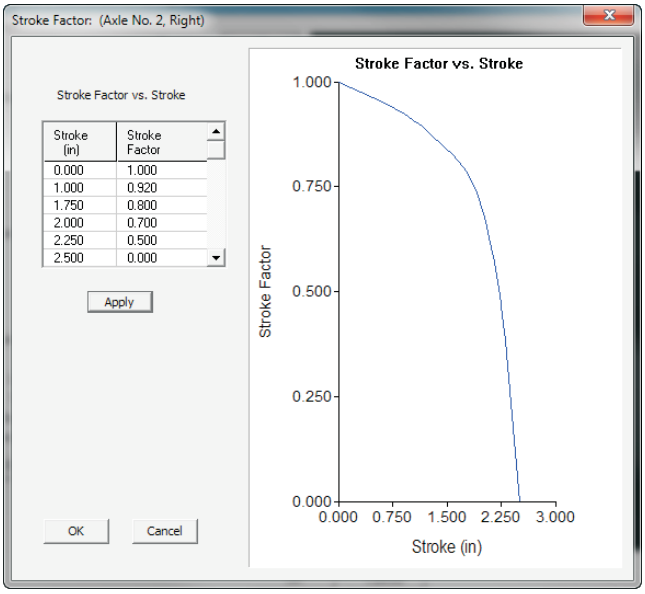
Available on-line in the EDC Library at www.edccorp.com

# Version 9 - Now Available and Ready for You

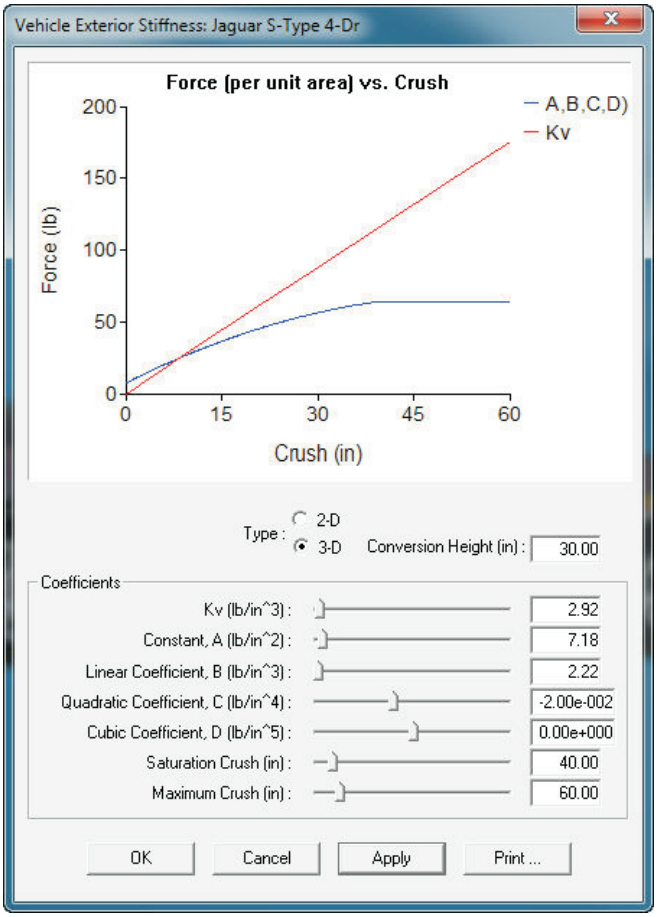
The weekly E-news broadcasts built to a crescendo with anticipation of the new high-definition (HD) video output and other simulation technologies and features offered in Version 9. Since April 20, 2012, Version 9 has been available and ready for you to capitalize on the following new capabilities:

- ***DyMESH* Version 3 - Wheel Impact**
- ***DyMESH* Version 3 - 3-D Stiffness Coefficients**
- **High-Definition Video Output - Video Creator**
- ***HVE* Driver Model Path Visualization**
- **Current Preferences Settings Display**
- ***HVE Brake Designer* Stroke Factor Table**
- **Dynamic Report Scrolling in Playback**
- **2-D Suspension Modeling**
- **Steady State Vehicle Handling Properties Report**
- **Environment Data Terrain Properties Report**

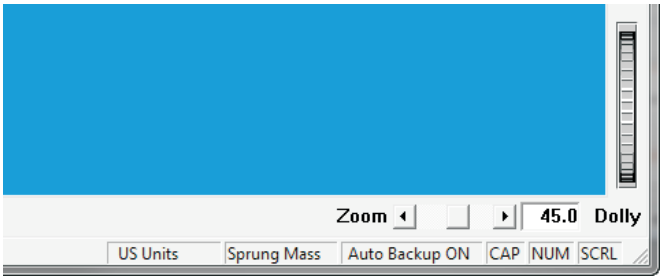
More information about these and other enhancements available in *HVE*, *HVE-2D* and *HVE-CSI* Version 9 can be found online at www.edccorp.com/Version900.




*The HVE Brake Designer for S-Cam brakes now includes a Stroke Factor vs. Stroke table, replacing the bi-linear method.*




*DyMESH Version 3 uses 3-dimensional stiffness coefficients that employ a 3rd-order force vs. displacement relationship with crush saturation.*




*The current settings for Units, Vehicle Dimension Basis, Auto Backup and Keyboard Settings are now displayed in the lower right corner of the program window.*

# Technical Session

Our Technical Session addresses the task of simulating a curb-tripped rollover. As this article shows, a successful curb-tripped rollover simulation requires the use of several *HVE* features.

We will use as an example the simulation of an intersection collision in a recent EDC promotion. That example involves a vehicle towing a trailer (bullet vehicle) striking an SUV (target vehicle) in the driver's door, resulting in the SUV sliding into a curb, tripping, and rolling over onto its roof, then coming to rest on its side. Figure 1 shows the vehicle as it approaches the curb. To see a video of the entire crash sequence, see www.edccorp.com/curbimpact.

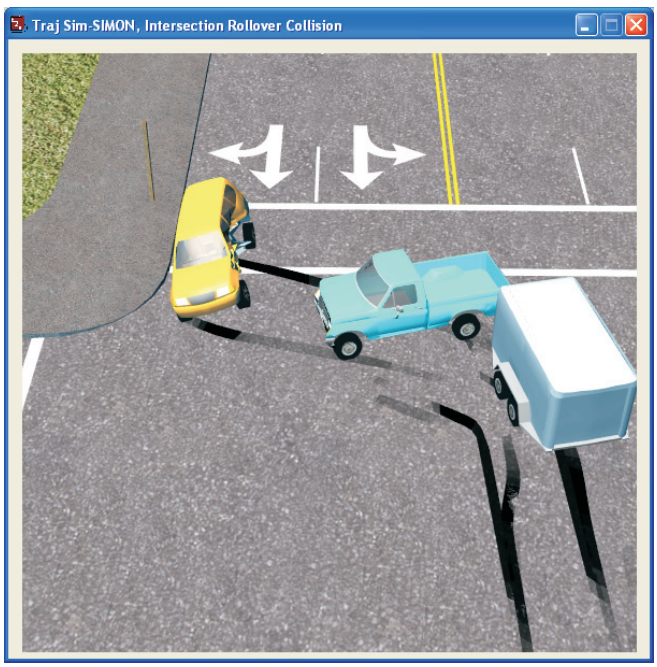
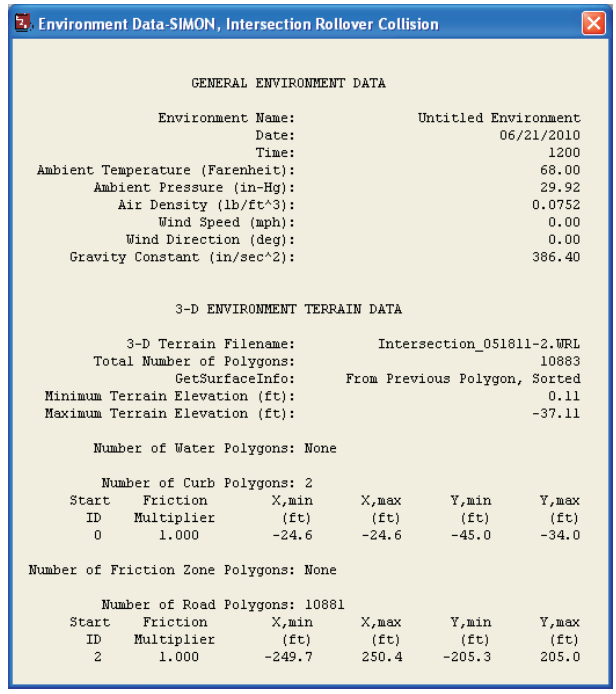



Figure 1 - Curb-tripped Rollover crash sequence, shown as the struck SUV approaches the curb.

The crash sequence was created in three separate *SIMON* simulations. Breaking the sequence into three simulations makes it possible to focus on the particular technical issues associated with each phase of the overall crash sequence. These phases are (a) the initial collision, (b) the SUV's curb-tripped rollover, and ©) the SUV's subsequent rollover, first onto its roof and then onto its side. Addressing these issues separately and then later combining them in the Playback Editor greatly reduces the amount of time required to perform the simulations and allows the user to work very efficiently.



Environment Data-SIMON, Intersection Rollover Collision

GENERAL ENVIRONMENT DATA

| | |
|---|---|
| Environment Name: | Untitled Environment |
| Date: | 06/21/2010 |
| Time: | 1200 |
| Ambient Temperature (Farenheit): | 68.00 |
| Ambient Pressure (in-Hg): | 29.92 |
| Air Density (lb/ft^3): | 0.0752 |
| Wind Speed (mph): | 0.00 |
| Wind Direction (deg): | 0.00 |
| Gravity Constant (in/sec^2): | 386.40 |

3-D ENVIRONMENT TERRAIN DATA

| | |
|---|---|
| 3-D Terrain Filename: | Intersection_051811-2.WRL |
| Total Number of Polygons: | 10883 |
| GetSurfaceInfo: | From Previous Polygon, Sorted |
| Minimum Terrain Elevation (ft): | 0.11 |
| Maximum Terrain Elevation (ft): | -37.11 |

Number of Water Polygons: None

Number of Curb Polygons: 2

| Start ID | Friction Multiplier | X,min (ft) | X,max (ft) | Y,min (ft) | Y,max (ft) |
|---|---|---|---|---|---|
| 0 | 1.000 | -24.6 | -24.6 | -45.0 | -34.0 |

Number of Friction Zone Polygons: None

Number of Road Polygons: 10881

| Start ID | Friction Multiplier | X,min (ft) | X,max (ft) | Y,min (ft) | Y,max (ft) |
|---|---|---|---|---|---|
| 2 | 1.000 | -249.7 | 250.4 | -205.3 | 205.0 |

Figure 2 - Environment Data report listing each type of polygon in the terrain.

## Procedure

Before creating our curb-tripped rollover event, we will add a single rectangular polygon at the face of the curb in the vicinity of the tripped tire. This is done using the *HVE* 3-D Editor and is a simple and straight-forward process. The key to this step is to make this polygon of type *Curb*. A new feature in the Sidewall Impact model for *HVE* Version 9 allows the user to choose to have the tire sidewall interact only with polygons of type *Curb*. This drastically reduces the simulation time because the sidewall springs need only to look at two polygons (triangles), instead of testing every polygon in the environment (the environment in this example has 10881 *Road* polygons!). The new Environment Data report in Version 9 lists the number of each type of polygon in the terrain (see Figure 2).

The initial conditions for the curb-tripped rollover simulation came from the position and velocity of the SUV at the end of the simulation of the initial collision phase. These results are as follows:

Position -
X = -21.25 ft, Y = -32.76 ft, Z = -3.06 ft
Roll = 17.71 deg, Pitch = 2.71 deg, Yaw = 87.70 deg

Velocity -
Vt = 27.87 mph, Sideslip = 126.73 deg, w = -8.82 mph
$\dot{\phi}$ = 32.63 deg/sec, $\dot{\theta}$ = -54.82 deg/sec, $\dot{\psi}$ = -135.44 deg/sec

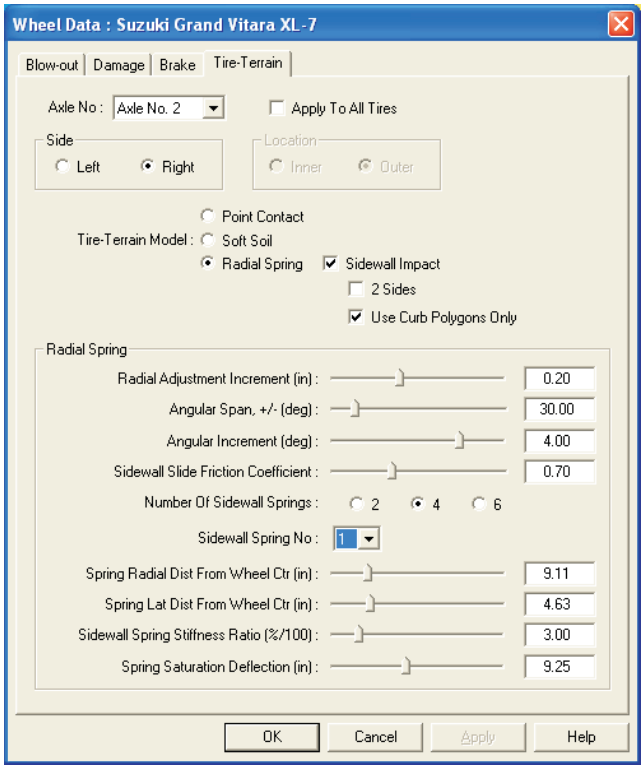



Figure 3 - Set-up, Wheels, Tire-Terrain model page

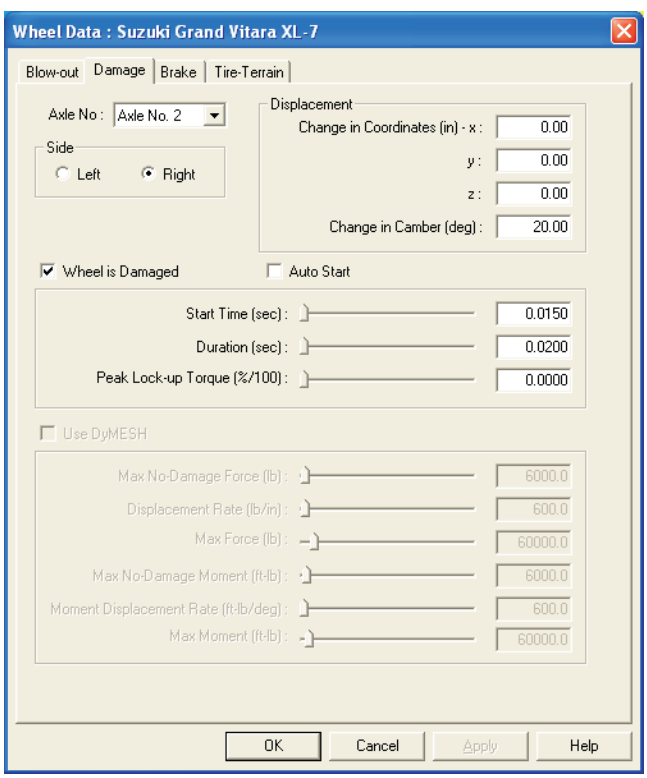



Figure 4 - Set-up, Wheels, Damage page

To set up a simulation that includes a sidewall impact, we need to select the tire(s) that are interacting with the curb and turn on the *Sidewall Impact* option. This is performed using the *Set-up* menu, *Wheels* option, *Tire-Terrain* page (see Figure 3). The *Radial Spring Tire-Terrain* model is selected, and the *Sidewall Impact* option is checked. As described above, we will also check the *Use Curb Polygons Only* option. We will make two more edits to the default *Radial Spring* and *Sidewall* data. The first is to reduce the *Angular Span* from its default value, +/- 90 degrees, to +/- 30 degrees. This speeds up the simulation because it reduces the number of radial springs by 2/3. We can do this because the height of the curb is only 6 inches. The second change is to increase the *Sidewall Spring Stiffness Ratio*. This is often required, especially at impact speeds greater than 20 mph. In our simulation, the vehicle is traveling about 28 mph, and a portion of the (extremely stiff) wheel also interacts with the curb. Therefore, we'll increase the *Sidewall Spring Stiffness Ratio* to 3.0. This value is the result of lots of experience; it is not the result of rigorous analysis.

Many curb-tripped rollovers result in damage to the suspension, causing the wheel to fold under (i.e., the camber increases significantly). Failing to observe and account for this damage during a high-speed, curb-tripped rollover will generally result in an excessive sidewall impact force and event termination. Suspension damage can be accounted for using the *Set-up* menu, *Wheels* option, *Damage* page. In our example, the wheel folded under, increasing the camber by 20 degrees. The wheel damage started at initial contact with the curb (at 0.015 sec), and occurred very quickly, over a 0.020 sec interval (see Figure 4).

Different events may require other event set-up options (e.g., Driver Controls, Accelerometers), depending on the particular needs of the simulation.

Another important step for curb-tripped rollover simulations is to reduce the Trajectory integration timestep to 0.0001 seconds from its default value, 0.0025 seconds. The reason for this is as follows: In our simulated event, when the SUV reaches the curb, it is traveling 28 mph, 493 in/sec. Therefore, in a single integration timestep the SUV will move 493 x 0.0025 = 1.23 inches. While this may not seem like a lot, the width of the tire is only about 9 inches, thus, if the default timestep is used, the tire will interact with the curb for a maximum of only seven timesteps. By reducing the integration timestep, we will increase the maximum number of interacting timesteps to 182. This creates the potential of adding much greater detail to the calculations describing the interaction between the tire and the curb.

While we're setting the Trajectory timestep, we will also reduce the simulation output interval from the default, 0.10 seconds, to 0.001 seconds. Updating the vehicle's

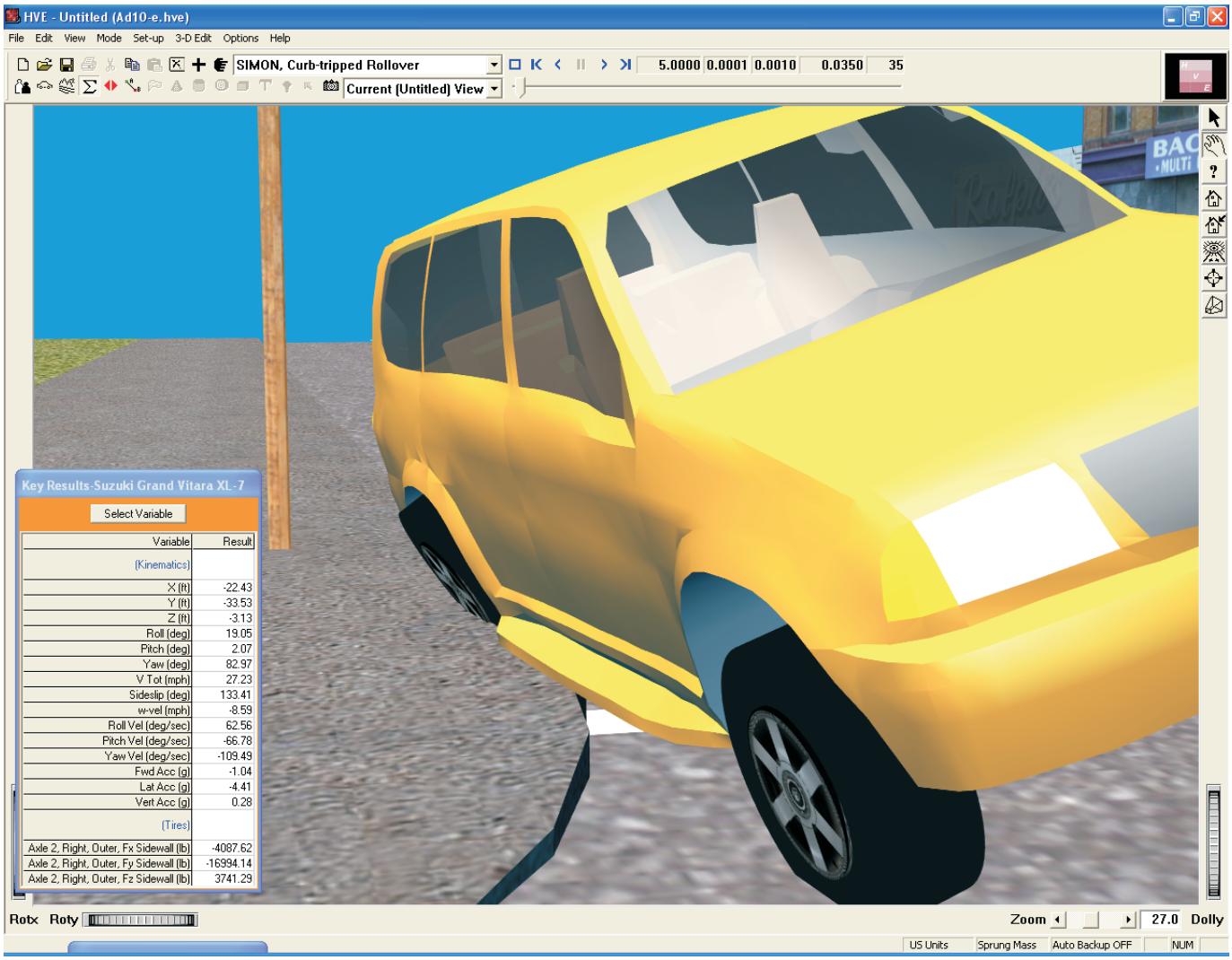



Figure 5 - Executing the event, shown at the time of curb impact, zooming in on the wheel vs. curb contact. Note the Key Results.

motion state more frequently allows us to better monitor the progress as the rollover occurs.

To get the greatest understanding of what's going on, we'll display the Key Results windows, selecting the results shown in Table 1. These results allow us to closely monitor the vehicle roll angle and roll velocity, and the tire sidewall forces as the curb-tripped rollover commences.

Now we can execute the event. Zooming in on the wheel as it impacts the curb allows us to *visually* confirm that the interaction is correct. As the simulation continues, we watch the vehicle go airborne and roll over. The simulation is terminated when the roof first contacts the ground (since *DyMESH* is not turned on, the collision with the ground is not simulated). This allows for a quicker and more efficient simulation of the curb-tripped phase. Just before the roof hits the ground, the position and velocity are as follows:

Position -
X = -35.96 ft, Y = -44.24 ft, Z = -4.10 ft
Roll = 65.21 deg, Pitch = 4.87 deg, Yaw = 37.53 deg

Velocity -
$V_t$ = 25.04 mph, Sideslip = -177.37 deg, w = -0.34 mph
$\dot{\phi}$ = 99.09 deg/sec, $\dot{\theta}$ = -90.23 deg/sec, $\dot{\psi}$ = -38.29 deg/sec

These parameters become the initial conditions for the simulation of the third portion of the crash sequence: the *DyMESH* simulation of the vehicle interacting with the terrain during the final portion of the rollover.

Table 1 - Key Results selections

| Group | Variable |
|---|---|
| Kinematics | X (ft) |
| | Y (ft) |
| | Z (ft) |
| | Roll (deg) |
| | Pitch (deg) |
| | Yaw (deg) |
| | V Total (mph) |
| | Sideslip (deg) |
| | w-vel (mph) |
| | Roll Vel (deg/sec) |
| | Pitch Vel (deg/sec) |
| | Yaw Vel (deg/sec) |
| | Forward Acc (g) |
| | Lat Acc (g) |
| | Vert Acc (g) |
| Tires | Axle 2, Right, Outer, Fx Sidewall (lb) |
| | Axle 2, Right, Outer, Fy Sidewall (lb) |
| | Axle 2, Right, Outer, Fz Sidewall (lb) |

## Summary

*HVE* supports curb-tripped rollover simulation using the *SIMON* vehicle dynamics model. To help ensure a successful result, the following steps are suggested:

- Reduce the integration timestep and output interval
- Use the *Radial Spring Tire-Terrain* model with the *Sidewall Impact* and *Use Curb Polygons Only* options
- Use the wheel *Damage* option to simulate suspension damage
- Create a *Curb* polygon to reduce the calculation time

Finally, breaking the crash sequence into two or three individual simulation events can make the user more efficient when performing the analysis.

### Rate This Tech Session

Please go to www.edccorp.com/TechSessionRating to tell us if you liked this Technical Session and to suggest other topics you'd like to see in future technical sessions in the EDC Technical Newsletter. Thank you!

# *HVE* Admissibility List

The *HVE* Admissibility List (EDC Tech Pub 3029) is a spreadsheet of court case details voluntarily provided by users of *HVE* and *HVE-2D*. The information contained in this publication has been extensively used to inform courts that *HVE* simulations and reconstructions are readily accepted as evidence to support the opinions of expert users. We encourage all users to support the continued growth of the *HVE* Admissibility List by providing the case citations to EDC Customer Service.

# 2013 *HVE* Forum

## March 11 - 15, 2013

## Westin Gaslamp Quarter • San Diego

Make plans now to attend the 2013 *HVE* Forum, from March 11 - 15, 2013, at the Westin Gaslamp Quarter in San Diego, California. The 2013 *HVE* Forum is where you will learn how to use the latest features and capabilities of *HVE*, *HVE-2D* and *HVE-CSI*. An excellent selection of workshops is available, designed for beginning, intermediate and advanced users. In addition, the Forum has User's Group meetings, the *HVE* White Paper session and interactive networking social hours at the end of each day. Check out this perfect location:

Westin Gaslamp Quarter - San Diego
910 Broadway Circle, San Diego, CA 92101
www.westingaslamp.com

Workshop schedules, descriptions and registration forms will be available this summer on the 2013 *HVE* Forum pages at www.edccorp.com/2013HVEForum.

# Call for Papers: *HVE* White Paper Session

Users interested in presenting a technical paper in the *HVE* White Paper session at the 2013 *HVE* Forum are invited to submit an abstract for consideration. Please submit your abstract to EDC Customer Service before September 1, 2012.

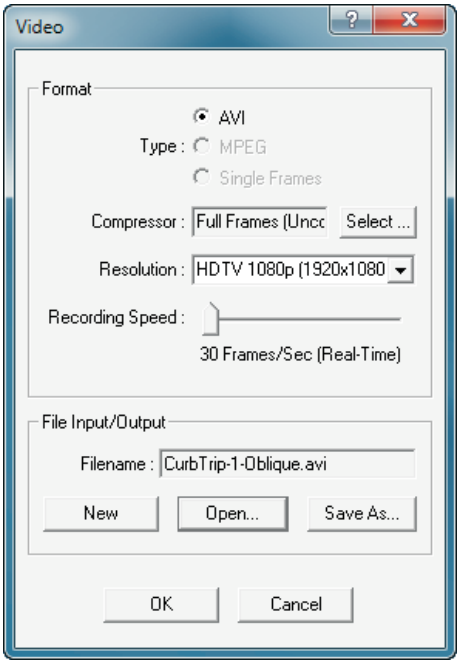
This session is an opportunity to showcase your skills to other users as well as to *non-HVE* users who are interested in your services. Topics include *HVE* Case Studies, applications showcasing its capabilities, and innovative tips and techniques using *HVE*. Please visit the *HVE* White Paper section of the EDC website library for a complete list of previous papers.

# Using the Video Creator in Version 9

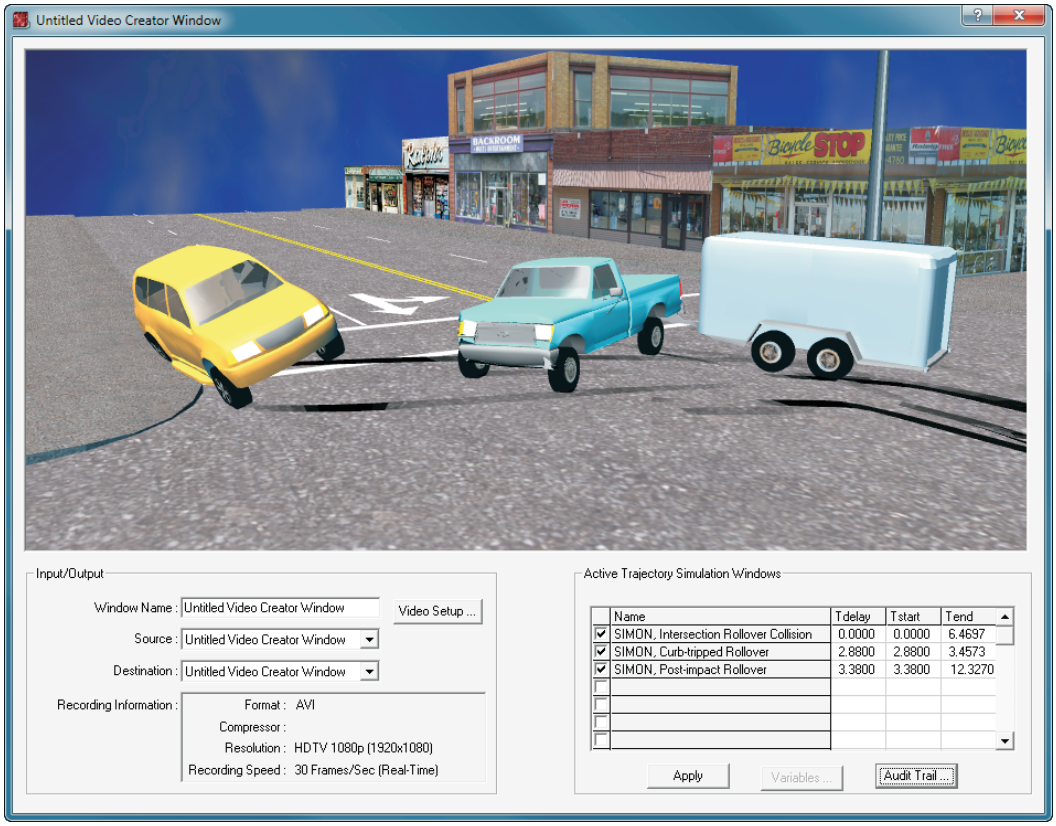
The Playback Window, used for creating simulation movies, has been redesigned and is now called the Video Creator. Users can take advantage of new off-screen rendering capabilities to produce movies in standard (640 x 480), DVD (720 x 480) and high definition HD (1280 x 720 or 1920 x 1080) AVI formats. Improvements also include the ability to control the recording speed frame rate to produce slow-motion movies directly in the Video Creator.

The design of the Video Creator is similar to its predecessor, the Playback Window, and uses the same basic steps that users have been comfortable with for years. Once you have added Trajectory Simulation windows for the selected events in the Playback Editor, you go to the main menu and select *File*, *Video Creator* and the Video Creator window will appear as shown below.

A viewer displays all the selected events, same as before. Below the viewer you'll find the Input/Output group, used for setting the Source, Destination and Recording Information. You'll also find the table of Active Trajectory Simulation Windows, used to adjust start, stop and delay time settings when creating a video of a combined sequence of events.




The Video Setup button provides quick access to the Video dialog as shown above, allowing you to select movie recording settings for video type, codec, resolution size and recording speed. Adjusting the recording speed allows you to create slow-motion videos of your crash sequence (setting the frame rate greater than 30 frames/sec results in a slow-motion video).




To set the camera view, choose any of the existing cameras (the Video Creator inherits all of the cameras from each event) before recording the video. You can also create and save new cameras using any of *HVE*'s traditional methods.

During the beta testing of Version 9, the new Video Creator received rave reviews. Try it for yourself to find out why!

# *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 trying to install the Version 9 update on my primary computer, I was unable to find my new license file on the installation CD. However, if I use the same CD to install on a different computer in my office, I am able to find and select the license file on the CD. Why can I not see the license file on one computer, but easily see it on another?*

A. With feedback from users during the Version 8.20 and not the Version 9 updates, we have learned there is a small percentage of computers that have DVD/CD drives that are not reading the information of the license file as expected. Your license file is added to your personal installation CD after it has been duplicated from the master installation CD. According to computer hardware blogs, it seems that hardware manufacturers are using lower cost internal components in new computer drives that may be the culprit in not being able to see the license file on certain computers.

If you find that you are unable to see the license file on your CD, please call or email Technical Support and we will email you the file. Alternatively, if you have another computer that does see the file on the CD, you can just transfer the file onto your main computer's hard drive and quickly complete your update installation.

*Q. I've just updated to Version 9 and I am trying to re-run an existing EDVTS event from Version 8.20 that involves a vehicle towing a trailer. When I reset the event and press Play, I keep getting the "Bad or Incompatible Event Data: Inter-vehicle connection Z elevations between two vehicles are different". I used the proper technique to match the tow and towed vehicle connection heights within 1 inch of each other when I created the event, but now in Version 9 it seems to have a problem. What happened?*

A. In the Version 9 Release Notes for *EDVTS*, the following note explains the situation - "A difference in the earth-fixed connection height for a tow vehicle and trailer results in a small trailer pitch angle that accelerated both vehicles. This issue was addressed earlier by allowing the maximum difference in earth-fixed connection height to be no greater than 1 inch. An acceleration still occurred, however. The allowable difference in earth-fixed connection height has been further reduced from 1.0 inches to 0.10 inches."

*Q. I left HVE open overnight, but when I came in the next morning, I saved the file and closed HVE. I'm trying to open the file now and it seems to have become corrupt. What happened?*

A. We've had a couple reports over the last year from users that have left their *HVE* casefile open for extremely long periods (overnight or longer), and then returned to their computer, saved their case, exited *HVE* and found they are unable to reopen their last case. One common thread in these reports is the use of a very large, high-resolution aerial image as the environment model. We are not certain, but it is possible that due to hibernation, background disk management optimization or other operating system activities, the information of the case file that has been open for the exceptionally long time has been disturbed. When the case file is saved that final time the next "day", this disturbed information is written into the case file causing the corruption. We recommend that users work in *HVE* and then save and close the program if you are going to be away from it for an extended period of time.

*Q. I am trying to open a Version 9 case using my Version 8 software. It won't open it. Why not?*

A. Case files are not backwards compatible. Newer versions can open older case files, but not vice versa.

*Q. I've just updated to Version 9 and I am not able to find the Roll Couple Distribution field in the Calc Options dialog for EDSVS or EDVTS as I used to. I can see it in the Vehicle Data report after I run my event, so I know it is still being used in the calculations. How do I adjust the settings for the vehicle's suspension to change the value for Roll Couple Distribution?*

A. In the Version 9 Release Notes for *EDSVS*, *EDVTS* and *EDSMAC4*, you will find the following note - "If you wish to duplicate the results from a previous run, use the Vehicle Editor's Suspension dialog for the front axle, setting the Lateral Load Transfer Coefficient to the Roll Couple Distribution previously assigned in the Calculation Options dialog." Please note that all three programs now support the adjustment of the Lateral Load Transfer Coefficient for vehicles. Previously, *EDSMAC4* was hard-coded to use Roll Couple Distribution values of 0.12 for heavy trucks and 0.55 for all other vehicles.

**Visit the Support section of www.edccorp.com for the latest Downloads and answers to F.A.Q.s**

# EDC Training Courses

## EDC Reconstruction & EDC Simulations

EDC offers excellent one-week courses on the use of the *EDCRASH* reconstruction program or the use of simulation programs, such as *EDSMAC*, *EDSMAC4*, *EDSVS* and *EDVTS*. The **EDC Reconstruction** and the **EDC Simulations** courses are designed to fully investigate the inner workings of the 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 workshops 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 user interface. For courses on using HVE, HVE-2D or HVE-CSI, check out the HVE Forum.*

## 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.

Engineering Dynamics Corporation
Training Course Schedule

**EDC Simulations**

Los Angeles, CA . . . . . January 2013
Miami, FL . . . . . November 2013

**EDC Reconstruction**

Los Angeles, CA . . . . . January 2014
Miami, FL . . . . . November 9 - 13, 2012

**Theoretical & Applied Vehicle Dynamics**

Upon Request

**2013 *HVE* FORUM**

San Diego, CA . . . . . March 11 - 15, 2013

## *HVE* Forum

The ***HVE* Forum** offers 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.

## Course Registration

To register for a course, download a registration form from the Training page at edccorp.com or contact EDC Customer Service at 503.644.4500 or by email to 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 compatible physics programs.

# *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:

Yahoo - tech.groups.yahoo.com/group/HVErecon - Discussion group hosted by Beck Forensics, Inc.

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

Engineering Dynamics Corporation
8625 SW Cascade Blvd, Suite 200
Beaverton, Oregon 97008 USA
Phone 888.768.6216/ FAX 503.526.0905
Email: info@edccorp.com
Website: www.edccorp.com