ENGINEERING DYNAMICS COMPANY

HVE Dialog Reference

HVE Human Vehicle Environment

Markdown Edition — revised to describe the current version of the software

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User Interface

Dialog and feature reference for the HVE **User Interface** area, converted from the on-line help. Part of the HVE Manual.

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3-D Editor Menu

The purpose of the 3-D Editor is to provide the user a tool to create and edit 3-D objects used to visualize humans, vehicles and environments. In addition to providing visual information, the surfaces are also physical surfaces, with physical properties, including surface normal and friction properties, that simulate a physical environment for human and vehicle dynamics models.

The 3-D Edit menu contains the following items:

Launch 3-D Editor (Ctrl+L)

Launches the 3-D Editor.

Material Color

Used to set the material color of the selected object. The Material Color dialog box is displayed; set the color using that dialog.

Material Texture

Displays the Texture Editor dialog box.

Manipulators

Choose a manipulator for the selected object. Choosing Manipulators from the menu displays a cascade menu listing the various manipulators available for manipulating (positioning and orienting) objects using the 3-D Editor. The following manipulators are available:

- **Direct** — No manipulator is used. Instead, the user clicks directly on the object and moves it.
- **Jack** — Scales the selected object in all directions; no translation or rotation.
- **Trackball** — Used for 3-dimensional rotation of the selected object; no translation.
- **Centerball** — Translates the object center to new X,Y,Z coordinates and rotates the object about the new center.
- **Handle Box** — Provides 3-dimensional translation and scaling of the selected object.
- **Transform Box** — Scales the object in all directions; translates and rotates the object in the selected direction.
- **Tab Box** — Translates the object in the selected plane.

Object Tools (Toolbar)

The 3-D Editor is used for creating and editing the objects used by HVE. These objects are broadly categorized as human, vehicle or environment objects. The user creates and edits these objects using the 3-D Editor's selection of creation and editing tools.

An object, such as a surface or sphere, is always created by first selecting an object tool from the toolbar. The following object tools are available:

- **Surface Tool** — Used for creating surfaces, such as roads, shoulders and adjacent highway environment.
- **Cone Tool** — Used for creating cone-shaped objects, such as traffic cones.
- **Box Tool** — Used for creating box-shaped objects, including buildings, sidewalks and bridges.
- **Sphere Tool** — Used for creating spherical and ellipsoidal shaped objects, such as commercial building signs.
- **Cylinder Tool** — Used for creating cylindrical-shaped objects, such as signs, sidewalk corners and tanks.
- **Text Tool** — Used for labeling objects such as signs, buildings and vehicles.
- **Light Tool** — Used for creating light sources in the environment.
- **Signal Tool** — Used for creating traffic signal lights in the environment.
- **Edit Tool** — Used for editing existing objects.

Object Attributes

Every object created using the 3-D Editor has attributes (name, type, overlay, material, friction factor, and related properties). Choosing this option displays the Object Attributes dialog box. For more information, see Object Attributes Dialog Box.

Viewer

Displays the 3-D Editor Viewer Options dialog. Use the

Show Viewer(s)

drop-down to select which viewer layout is displayed while editing: the XZ (side), YZ (front), or XY (plan) orthographic viewer, the Perspective viewer, or All (all four viewers at once).

Close 3-D Editor

Closes the 3-D Editor and returns to the Environment Editor. Changes made to the current object are automatically applied to that object.

Updated to match the current version of HVE.

Camera Setup Dialog Box

The Camera Setup dialog uses a camera metaphor to determine how a scene is viewed: viewing a scene is much like looking through a camera. The dialog also lets the user save and delete named views, so several views can be defined and re-used.

This dialog box contains the following options:

View Name

A drop-down list of the available views. The list contains the current view (shown as

Current (Untitled) View

) only while it is unsaved, plus any saved cameras. Selecting a camera loads its settings into the dialog.

View From — Object Name

The View From object list allows the user to select the object to which the camera is attached. This list contains all the objects (humans, vehicles and the environment) in the event. Attaching the camera to a human or vehicle causes the view to move with the human or vehicle.

View From — X, Y, Z

The coordinates of the camera. These coordinates are relative to the selected View From object. For example, if the View From object is a vehicle, setting the coordinates to 0,0,0 means the scene will be viewed from the vehicle's CG, regardless of the vehicle's location in the environment.

Use Vehicle's Vertical

When checked, the camera's up direction follows the View From vehicle's vertical (body-fixed) axis, so the view rolls and pitches with the vehicle. When unchecked, the camera up direction remains earth-fixed vertical.

Make Glass Clear

When checked, the window glass of the View From vehicle is rendered fully transparent. This is useful for views from inside a vehicle (e.g., a driver's-eye view), where tinted glass would otherwise obscure the scene.

Look At — Object Name

Selects the object at which the camera is aimed. The Look At coordinates below are relative to this object, so the camera can, for example, be attached to one vehicle while continuously aimed at another.

Look At — X, Y, Z

The picture center defines the coordinates at the center of the viewer. The coordinates are relative to the Look At object. For example, if the Look At object is a vehicle, setting the picture center to 100,0,0 causes the picture center to be 100

feet ahead of the vehicle, regardless of the vehicle's position or orientation.

Near

The depth of field is defined by near and far clipping planes. Any object closer to the camera than the near clipping plane will not be rendered in the scene. Specify the near clipping distance here.

Far

Any object farther from the camera than the far clipping plane will not be rendered in the scene. Specify the far clipping distance here.

Focal Length

The focal length of a virtual 35mm camera used to visualize the scene. A focal length of 50mm is the default and represents a normal view. Focal lengths less than 50mm are wide-angle lenses; greater than 50mm are telephoto lenses.

Camera Tilt Angle

Rotates the camera about its viewing axis, tilting (banking) the picture. A tilt angle of 0 degrees keeps the horizon level.

Save...

Saves the current settings as a named camera. The camera is added to the Camera list so it can be recalled later.

Delete...

Deletes the currently selected saved camera.

OK / Cancel / Apply

Apply applies the current settings to the viewer without closing the dialog; **OK** applies the settings and closes the dialog; **Cancel** closes the dialog without applying changes.

Updated to match the current version of HVE.

Key Results Dialog Box

This dialog box, whose title bar reads

Key Results-\<object name>

, displays user-specified results during Event and Playback modes. Key Results are especially useful during Event mode to monitor the values of one or more variables at each time step. Use the Variable Selection dialog to select which variables are displayed in the Key Results window. A separate Key Results window is displayed for each human and vehicle in the event.

The window is resizable, and its contents differ slightly between reconstruction events (which display a single set of results) and simulation events (which display values updated at each output time interval).

Select Variable

Click this button to choose which variables are monitored. The Variable Selection Dialog Box is displayed, listing the available output groups and variables for the object. This button is enabled only for simulation events; in reconstruction events the variable set is fixed and the button is disabled.

Key Variable Grid

A two-column grid showing the selected variables:

- **Variable** — The name of each variable selected in the Variable Selection Dialog Box, grouped by output group.
- **Result** — The current value of the corresponding variable, displayed in the current user units. During a simulation the values update at the current simulation time; for a reconstruction the computed results are shown.

See also: Event Mode, Playback Mode, Variable Selection Dialog Box, and the *Key Results* preference in the User Preferences Dialog Box, which controls the initial variable selection for new events.

Updated to match the current version of HVE.

Light Editor Dialog Box

The Light Object Tool allows the user to create and edit light sources. Lights are objects that cast light on other objects, making them visible.

Lights are unique in several ways:

- You cannot see them, only the effects caused by them (i.e., other objects are lit up).
- Lights cannot be grouped like other objects can. This means you cannot create a streetlight that includes a light source that moves when you move the streetlight; instead, you must re-attach the light after you have positioned the pole.

The Light Editor dialog provides the following options:

Coords (ft) — X, Y, Z

The coordinates of the light source. Used for *Point* and *Spot* lights; for *Directional* lights the position values are simply ignored (a directional light illuminates from a direction, not a location), although the fields remain enabled.

Angle (deg) — Azimuth, Zenith

The direction in which the light points, entered as an azimuth (heading) angle and a zenith (angle from vertical). These fields are used for *Directional* and *Spot* lights. (Earlier versions of this dialog used Roll/Pitch/Yaw angles; the current dialog uses Azimuth/Zenith.)

Global / Local

A combo box selecting whether the entered coordinates and angles are interpreted in the global (environment) coordinate system or the object's local coordinate system.

Light Is On

Check box that activates and deactivates the light source.

Type

- **Point** — The light source is located at user-specified coordinates and radiates light in all directions. An example is a light bulb.
- **Directional** — The light source illuminates uniformly along a specified direction. Its location is not used. An example is the sun.
- **Spot** — The light source is located at user-specified coordinates and radiates a beam of light. An example is a headlight on a car.

Color...

Displays the Color dialog, used to specify the light's color.

Intensity

The brightness of the light (slider and edit field).

Drop-off Rate

For

Spot

lights only, the rate at which the light attenuates from the center of the beam to its edge.

Cone (deg)

For

Spot

lights only, the included angle of the cone of light.

Apply

Applies the current settings to the selected light.

Updated to match the current version of HVE.

Object Attributes Dialog Box

Every object created using the 3-D Editor has the following attributes:

Object Name

The Object Name is simply the name of the object tool used to create the object (e.g., *surface*, *box*, *cylinder*, etc.). If the selected object is a group composed of several individual objects, the Object Name is *Group*. If the grouped object was selected from the Highway Furnishings Library, the Object Name is the object's filename. This field is read-only.

Type

Every object created by the 3-D Editor has an Object Type attribute. The available types are:

- **Human** — The default object type attribute for humans.
- **Vehicle** — The default object type for vehicles.
- **Road** — The default object type for environments. Road objects have physical properties (surface elevation, normal and friction factor) used by the current reconstruction or simulation model.
- **Friction Zone** — An optional object type. Friction Zone objects have physical properties (surface elevation, normal and friction factor) used by the current reconstruction or simulation model.
- **Curb** — An optional object type identifying the object as a curb for calculation models that include curb impacts.
- **Water** — An optional object type identifying the surface as water. Selecting Water enables the Water Depth controls (see below).
- **Other** — An optional object type for purely visual objects.

Overlay

Every object created using the 3-D Editor belongs to a named overlay. Examples of named overlays are *Accident Debris* and *Measured Skids*.

HVE maintains a list of current overlay names. This list is available in the Overlays Dialog Box, displayed by choosing Overlays from the View menu. The user may display or remove one or more overlays using the Overlays dialog.

Overlays serve several very useful purposes. Some examples are:

- Overlays may be used to show an accident scene as it appeared before and after the accident by creating overlays named Accident Debris and Skidmarks. Turning off these overlays shows the scene as it appeared before the accident; turning them on shows the scene after the accident.
- An overlay may be used to compare simulated and measured skidmarks.
- A scanned image (bitmap) overlay may be used to compare a 3-D model of the accident site with a photograph to confirm the model's accuracy.

Material Name

A user-editable name identifying the material assigned to the object (e.g., asphalt, gravel). The name is stored with the object and shown in surface information output.

Friction Factor

Objects created using the 3-D Editor have friction properties. This friction factor is a user-editable object attribute used by the current calculation model to determine the frictional properties of the surface.

Use this option to create regions with different frictional properties from the base surface. Examples include gravel shoulders, oil slicks and other regions.

Water Depth (in)

Available when the object Type is

Water

. Two options are provided:

- **Static** (first radio button, with depth field) — The water has the user-entered constant depth over the surface.
- **Dynamic** — The water depth is determined dynamically from the water surface elevation and the underlying terrain.

Material Edit...

Displays the Material Editor dialog box, used to edit the visual material (color, texture) of the object.

Apply

Applies the current attribute settings to the selected object.

Group / UnGroup / Load / Save

A row of picture buttons at the bottom of the dialog:

- **Group** — Combines the currently selected objects into a single group object.
- **UnGroup** — Breaks the selected group back into its individual objects.
- **Load** — Loads a previously saved object (e.g., from the Highway Furnishings Library) into the scene.
- **Save** — Saves the selected object or group to a file so it can be re-used in other environments.

Updated to match the current version of HVE.

Options Menu

This menu includes the following options (in menu order):

Create DB

Rebuilds the HVE object database (ESNDB.db) from the database source files. All vehicle and human binary files are regenerated and the rebuilt database is reloaded. This may take a few moments; the cursor changes to an hourglass while the database is being created.

Show Key Results

Choosing this option displays a Key Results Dialog Box for each object. Key Results dialog boxes display the user-specified results during Event and Playback modes. Key results are especially useful during Event mode to monitor the values of one or more variables at each time step. Use the Variable Selection dialog to select which variables are displayed in the Key Results dialog box.

See also: Key Results Dialog Box, Event Mode, Playback Mode, Variable Selection Dialog Box.

Show Axes

Choosing this option displays a set of vectors in the X,Y,Z directions for each human and vehicle as well as the environment. The origin of the axis system is at the origin of the object. The axes are displayed in all modes.

Show Contacts

Choosing this option displays the physical contact surfaces used for generating forces between human ellipsoids and vehicle contact surface planes. Visualizing these planes can be very useful while creating the ellipsoids and surface planes, and also during Event mode when the interactions are being simulated. However, you may choose to hide contacts during Playback mode if you find them visually distracting.

Show Belt Anchors

Choosing this option displays the vehicle-fixed belt anchor locations for each belt restraint system installed in the vehicle. The location of the icon can provide important visual cues during event set-up as well as during execution.

Show Velocity Vectors

Choosing this option displays the current velocity vector during Event and Playback modes. Both relative magnitude and direction are shown. (The vector's length shortens as the vehicle slows.) This vector can provide important visual cues during event setup as well as during execution. (See also the

Long Velocity Vectors

option in the User Preferences dialog, which lengthens the displayed vectors.)

Show Skidmarks

Choosing this option displays tire skid marks and scuff marks calculated by the simulation model. Simulated tire marks are displayed for each tire, including duals, and are displayed according to the tire's width (based on the tire size designation).

Show Tracks

Toggles the display of the wheel track overlay — the path traced by each tire, whether or not the tire is skidding. Useful for comparing the simulated wheel paths against evidence at the scene.

Show CGs

Toggles the display of a symbol at each vehicle's center of gravity.

Show CG Paths

Toggles the display of the path traced by each vehicle's center of gravity during the event.

Show Accelerometers

Toggles the display of a symbol at each vehicle's accelerometer location.

Show Accelerometer Paths

Toggles the display of the path traced by each vehicle's accelerometer during the event.

Show Position Sequences

Toggles the display of position sequence overlays — a series of vehicle positions displayed at selected times during the event.

Show Targets

Choosing this option displays target humans and vehicles. Targets are positions you can enter during event setup that do not enter into simulation calculations (except for the HVE Path Follower), but allow you to visually compare how closely the simulated path matches the actual path represented by the targets. Simulation models may also perform error calculations based on the target positions and velocities to quantify the match between simulated and actual paths.

Target humans and vehicles are translucent to distinguish them from positions used by the calculation model.

Show Connections

Toggles the display of the connections (e.g., hitches and articulation points) between connected vehicles, such as a tractor and its trailer(s).

Distance Tool

Displays the modeless Distance Tool dialog, used for measuring distances in the viewer during Event mode. Available only when the case contains at least one event.

Show Path

Displays the Show Curved Path dialog for the current event. Use it to display a smooth (spline) curved path in the viewer based on the event's path positions; the path display is updated when the dialog is closed with OK.

Autoposition

Choosing this option causes vehicles to be positioned on top of the environment surface geometry. AutoPosition uses the current surface elevation beneath each wheel and the vehicle's tire radii and ride height to determine the earth-fixed Z coordinate of the vehicle CG which will place the vehicle in equilibrium at the start of a simulation. AutoPosition greatly simplifies initial positioning for 3-D simulations, which otherwise tend to take a while for the simulation to reach equilibrium.

AutoPosition does not include suspension and tire deflections. Therefore, a small disturbance may still be experienced, especially on 3-D terrain that does not form a plane beneath the tires.

AutoPosition is always used for 2-D reconstructions and simulations. Because these models do not include suspension effects, on severely non-planar surfaces tires may appear to come off the ground. This visual effect does not affect calculations.

Grid

Choosing this option displays markers at user-defined intervals. These markers are used as spatial cues to help determine distances while creating and editing 3-D models of humans, vehicles and environments. It displays the Set Grid Dialog Box.

Units

Allows the user to switch between US, SI and user-defined systems of units. Choosing this option displays the Units Dialog Box.

Shadows

Displays the Shadow Options dialog. Options include *Show Shadows* (turns shadow rendering on/off) and user-editable *Radius*, *Quality*, *Precision* and *Intensity* values that control the size, smoothness and darkness of the rendered shadows.

Render (Ctrl+R)

Choosing this option displays the Render Dialog. This dialog includes several user-definable options which affect the visual quality of the objects displayed by HVE.

Playback

Sets the playback time interval for the current playback window. It displays the Playback Options dialog box.

Simulation Controls (Ctrl+Y)

Choosing this option displays the Simulation Controls dialog box.

Calculation Options (Ctrl+J)

Choosing this option displays the Calculation Options dialog box for the calculation method currently selected for the event. The available dialogs include:

- EDCRASH — EDCRASH Calculation Options
- EDGEN — EDGEN Calculation Options
- EDHIS — EDHIS Calculation Options
- EDSMAC4 — EDSMAC4 Calculation Options
- EDSVS — EDSVS Calculation Options
- EDVDS — EDVDS Calculation Options
- EDVSM — EDVSM Calculation Options
- EDVTS — EDVTS Calculation Options

DyMESH

Displays the DyMESH Options dialog, containing options for the DyMESH 3-D collision algorithm.

Get Surface Info

Displays the Get Surface Information Options dialog for the current event. The selected options determine which surface information is retrieved beneath each tire; closing with OK re-tessellates the environment surfaces used by physics.

Preferences (Ctrl+F)

Customizes HVE according to various user-selectable preferences. Displays the User Preferences Dialog Box.

> Note: The
>
> *Add Playback Window*
>
> command described in earlier versions of this help topic is no longer located in the Options menu. Playback windows are added from Playback mode (see the Playback Information dialog).

Updated to match the current version of HVE.

Overlays Dialog Box

Choosing Overlays from the View menu displays the Overlays dialog. The Overlays dialog allows the user to display or remove objects from the scene.

Active Overlay List

This multiple-selection list box displays all the overlay names of the objects in the viewer. By default, all overlays are selected, and therefore all objects are displayed in the viewer. Click on an overlay name to remove all objects using that name; click it again to restore them.

Scanned Image Overlay

The Scanned Image check box is used to display or remove a scanned image from the environment. A scanned image may be used for the entire environment, or just the sky. The check box is greyed out (disabled) unless the environment actually contains a scanned image (backdrop).

Updated to match the current version of HVE.

Playback Controls (Toolbar)

The playback controls on the toolbar control execution of the current event during Event mode, and control replay during Playback mode. The following controls are available, in toolbar order:

Reset

Initializes the physics program and places the simulation at its starting conditions.

Rewind

Places the simulation at the starting position.

Reverse

Plays the simulation backwards.

Pause

Pauses the simulation.

Play

Starts (or resumes) the simulation.

Advance to End

Places the current simulation state at the end of the simulation.

Max Sim Time

Displays the maximum simulation time, i.e., the time at which the simulation will terminate.

Integration Time Step

Displays the time step used by the calculation method's numerical integration.

Output Time Interval

Displays the time interval at which output results (and playback frames) are produced.

Current Time

Displays the current simulation time.

Frame No

Displays the number of the frame currently being displayed.

Time Slider

A slider used to set the current simulation/playback time directly; drag it to move to any point in the event.

Updated to match the current version of HVE.

User Preferences Dialog Box

Choosing Preferences from the Options menu displays the User Preferences dialog box, which allows the user to customize HVE according to the following preferences.

> Note: Earlier versions of HVE displayed a smaller Preferences dialog containing a *Diagnostic Level* selection and *Set Window State* button. These options have been removed; the current dialog is described below.

Auto Backup

Turns the automatic case backup feature **On** or **Off**. Only one backup method is supported, and it is always active while Auto Backup is On:

- **Only on mode change after *n* minutes** — The case is backed up when the user changes modes and the specified number of minutes has elapsed since the last save. Use the minutes field and its spinner to set the interval.

Date Style

HVE allows the user to select from two date styles:

- **mm/dd/yy** — US Standard (month/day/year) format.
- **dd/mm/yy** — Military style (day/month/year). This style is also used in Europe and many other countries.

Hide Date/Time From Printed Reports

When checked, the date and time are omitted from the header of printed reports.

Key Results

Determines which set of key results variables is displayed in Key Results windows when a new event is created:

- **Use Default** — Uses the built-in default set of key results variables for the calculation method.
- **Use Previous** — Uses the same key results variables that were selected for the previous event.
- **Use Custom** — Uses a user-defined set of variables. Press **Edit...** to select the custom variable set (the Edit button is enabled only when the case contains at least one event with an object in it).
- **Copy to Variable Output** — When checked, the selected key results variables are also copied to the Variable Output report selections.

Vehicle Dimensions Basis

Selects whether vehicle inertial/dimensional data are displayed on a **Sprung Mass** or **Total Mass** basis. (Not available in all run modes.)

Set Background Color

Displays a color chooser used to set the background color of the viewers in the Human and Vehicle Editors.

Skidmark Height (ft)

User-editable height (delta) at which simulated skidmarks are drawn above the surface. Raising this value can prevent skidmarks from being partially hidden by the underlying surface geometry.

Font Size

Selects the font size (8, 10, 12, 14 or 16 points) used by numeric output reports. Changing the size immediately updates all open report windows.

Physical Monitor Width (in)

The actual width of the display monitor. This value is used to compute true scale for 2-D (scaled) viewers; it is not used, and is therefore disabled, when a 3-D perspective camera is active.

Long Velocity Vectors

When checked, velocity vectors displayed in the viewer (see Show Velocity Vectors in the Options menu) are drawn at increased length, making them easier to see in large environments.

Cycle Vehicle Colors

When checked, HVE automatically assigns a different body color to each vehicle added to the case, cycling through a list of colors so that vehicles are easier to tell apart.

Resolution Setting

Selects the size of the user interface (toolbar buttons and dialog scaling) to match the display resolution:

- **Auto Detect** — HVE chooses an appropriate size based on the current display.
- **Small**, **Medium**, **Large** — Force a specific UI size.

Changing the resolution setting displays a message; the new setting takes effect the next time HVE is started.

Store Vehicle Geometries in case file

When checked, each vehicle's 3-D geometry is stored inside the case file, making the case self-contained (useful when moving a case to another computer). This option is available only when the vehicles in the case can be saved to the case file and the vehicles have geometry files.

Reload language.rsc file on dialog exit

When checked, HVE reloads the language file when this dialog is closed. This lets you check edits to translated dialog labels without restarting HVE.

Updated to match the current version of HVE.

Report Window Dialog Box

This dialog (formerly titled

Set Preview Window

) is used when adding a playback window that displays a report for an event. It is used to select the event and the type of report to display.

This dialog contains the following options:

Active Events

Displays the list of events currently existing in the case. Select the event whose report you wish to display.

Status

A read-only field indicating whether the selected event has been run. Reports are only available for events that have been executed.

Name

Contains the name for the report window. It defaults to the event currently selected in the Active Events list and may be edited.

Report Type

A combo box containing all the available reports for the selected event. The user can select any report.

Updated to match the current version of HVE.

Render Dialog Box

Sets various options that affect the visual appearance of all 3-D objects displayed by HVE.

Humans and Vehicles — Show As

Separate

Show As

options are provided for humans and for vehicles:

- **Human — Actual** — HVE displays humans using the object's 3-D geometry file.
- **Human — Simple** — HVE displays humans as ellipsoids.
- **Vehicle — Actual** — HVE displays vehicles using the object's 3-D geometry file.
- **Vehicle — Simple** — HVE displays vehicles as simplified boxy-shaped objects.

> Note: The Human
>
> *Show As*
>
> options (Actual/Simple) are currently disabled (grayed out) in the dialog.

Render Method (Shading)

HVE provides the following render methods:

- **Phong** — Phong shading is required for realistic images. Only if Phong shading is selected are special lighting and shading calculations performed. Because of these calculations, Phong shading also has the longest rendering time.
- **Flat** — Displays each object according to its user-defined color(s). However, no lighting or shading calculations are performed, so objects appear less realistic compared to Phong shading; objects are rendered more quickly.
- **Wireframe** — Shows only the edges of each object; no surfaces are displayed. The resulting display is fast but realism is lost. Wireframe mode is often useful as a construction technique during model building in the 3-D Editor.
- **Hidden** — Like Wireframe, except it includes depth calculations; objects hidden behind other objects are not displayed. Like Wireframe, hidden line mode is often useful as a construction technique during model building in the 3-D Editor.

Complexity

The Complexity option specifies whether objects are drawn relative to object space or screen space:

- **Object** — All the object's polygons are rendered, regardless of the distance from the camera.
- **Screen** — HVE uses the object size and distance from the camera to decide whether to render all the object's polygons or just render its pixels at some average color.

> Note: The Complexity options are currently disabled (grayed out) in the dialog.

Show Only Faces

When checked, surfaces are rendered with backface culling, i.e., polygons are drawn as one-sided faces. Polygons whose normals face away from the camera disappear, making it easy to identify surfaces whose normals point the wrong way — such surfaces will not work correctly with the physics models. This option is available only when the *Phong* or *Flat* render method is selected.

Light Sources On

Turns user-created light sources (created with the Light Tool in the 3-D Editor) on or off in the rendered scene.

> Note: The Light Sources On check box is currently disabled (grayed out) in the dialog.

Render Quality

A user-definable range (1 to 10) which defines how finely objects are subdivided (tessellated). The default value is 5. If a value less than 5 is entered, objects like cones and spheres appear more blocky and surfaces may have unrendered areas. Selecting a value greater than 5 results in smoother cones and spheres; the appearance of surfaces may or may not improve (depending on how they were created). There is a trade-off between speed and image quality.

Texture Quality

A user-definable range that controls the resolution at which surface textures are rendered. Higher values produce sharper textures at the cost of rendering speed and texture memory; lower values render faster but textures appear blurrier.

> Note: The Texture Quality slider and edit field are currently disabled (grayed out) in the dialog.

Anti-Aliasing Level

A user-definable range (1 to 10) which defines how smoothly objects are rendered. The default value is 1. If a value greater than 1 is selected, objects are re-rendered up to 10 times (depending on the selected value), resulting in a significant improvement in image quality. However, rendering time is increased significantly.

Updated to match the current version of HVE.

Select Object Dialog Box

This dialog is not displayed on its own; it is a child panel embedded into the standard Windows file Open/Save dialog when HVE opens or saves objects and cases. It adds HVE-specific information alongside the standard file controls.

The panel contains the following controls:

Case Title

An editable field containing the title stored with the case. The title is saved in the case file and is displayed in reports.

Object Text

A label describing the object being opened or saved (its content depends on the current mode — human, vehicle, environment, event or playback).

File List

A sorted list box displaying the existing files of the appropriate type in the current folder.

Updated to match the current version of HVE.

Set Grid Dialog Box

Sets a user-definable distance interval for display and data entry in the environment. Grid markers are used as spatial cues to help determine distances while creating and editing 3-D models of humans, vehicles and environments.

This dialog box contains the following options:

Turn Grid On

Check box that turns the grid display on or off.

Grid Dimension (ft)

The distance between grid lines or markers in the 3-D editor viewers, in the current user units.

Updated to match the current version of HVE.

Sky Attributes Dialog Box

Sky attributes determine the appearance of the background when a 3-D geometry file is displayed.

The following attributes are available:

Ambient Light Intensity

A slider and edit field that determine the ambient lighting level in the scene. This attribute may be used for visualizing various levels of daylight, dusk/dawn and darkness.

Set Sky Color

Displays the Color dialog box. Use the controls in the dialog box to choose the desired color for the sky.

Fog Type

A user-selectable type of visual occlusion:

- **None** — No visual occlusion.
- **Haze** — Selects the visual occlusion as haze.
- **Fog** — Selects the visual occlusion as fog.
- **Smoke** — Selects the visual occlusion as smoke.

Visibility

A user-editable field defining the distance (from the camera) at which objects are no longer visible.

Set Fog Color

Displays the Color dialog box, used to set the color of the fog/haze/smoke.

Updated to match the current version of HVE.

Text Editor Dialog Box

The Text Object Tool allows the user to create and edit 3-D text. Text may be used to label signs, buildings and other objects. The Text Editor dialog displays information about the current text object.

Coords (ft) — X, Y, Z

The coordinates of the text object.

Angle (deg) — Roll, Pitch, Yaw

The orientation of the text object.

Global / Local

A combo box selecting whether the entered coordinates and angles are interpreted in the global (environment) coordinate system or the text object's local coordinate system.

Text

Allows the user to enter or edit the desired text string. The field is multi-line, so labels may contain several lines of text.

Height (ft)

Allows editing of the text height.

Apply

Applies the current settings to the selected text object.

Updated to match the current version of HVE.

Units Dialog Box

Allows the user to specify the current system of units. HVE maintains two basic sets of units: program units and user units.

Program units are always pounds, inches and seconds (and derivatives of these basic quantities). These units are used for all the internal workings and the user never sees them. Instead, the user sees the user units, which may be defined according to the user's needs through the use of the proper conversion factors. These conversion factors convert all the user's entries into program units so HVE can operate on them, and also convert all the program's results back into user units.

The dialog contains a

Current Units

group with three choices:

U.S

Sets US units as the current system of units.

S.I

Sets SI (metric) units as the current system of units.

Custom

Sets a user-defined system of units, built from custom conversion factors defined in HVE's unit resources. This allows mixing of unit choices (for example, US units with velocities in mph).

Pressing **OK** applies the selected unit system throughout HVE: key results displays, variable output reports, the Position/Velocity dialog and the Distance Tool are all immediately converted to the new units.

> Note: The
>
> *Set Custom Units*
>
> button described in earlier versions of this help topic is no longer present in the dialog.

Updated to match the current version of HVE.

Vehicles

Dialog and feature reference for the HVE **Vehicles** area, converted from the on-line help and verified against the current release. Part of the HVE Manual.

Pages

- A Stiffness Coefficient Dialog
- Body Torsion Dialog
- B Stiffness Coefficient Dialog
- CG To Front
- CG To Back
- CG To Top
- CG To Left
- CG To Right
- CG To Bottom
- Inertia Dialog Box
- Moving CG
- Payload Dialog Box
- Sprung Mass Dialog
- Stiffness Coefficient Dialog
- Vehicle Drag Dialog
- Getting Information about the Vehicle
- Vehicle Inertia Dialog
- Saving Vehicles

A Stiffness Coefficient Dialog

A Stiffness Coefficients Dialog Box

The selected vehicle's stiffness coefficients are normally used for damage-based calculation methods. Choosing A Stiffness displays a dialog showing the current A-stiffness values for each crush zone. These coefficients are initially assigned by the Vehicle Editor when the vehicle is created and may be replaced by user-entered values for each crush zone. Each value may be set either with its slider or by typing directly into the edit field.

Zone 1 - 9

Enter the A-stiffness coefficient for the zone. Only the zones defined in the current damage profile are enabled; the remaining zone fields are disabled.

All Same As Zone 1

Assigns the A-stiffness coefficient of the first zone to all the zones.

Updated to match the current version of HVE.

Body Torsion Dialog

Body Torsion Dialog Box

The HVE Vehicle Model includes the capability to model torsional distortion of the body. By default, the body is assumed to be rigid. However, the user may wish to edit these default parameters, if the actual torsional stiffness of the body is known, to study the effect of torsional distortion on vehicle handling. The Body Torsion dialog is used to edit these properties. Each value may be set either with its slider or by typing directly into the edit field.

The parameters of this dialog are as follows:

CG to Torsion Axis

Specify the vehicle-fixed z-distance from the CG to the torsional roll axis. The distance is displayed relative to the sprung-mass CG or the total-mass CG, according to the current Vehicle Dimensions Basis selected in the user options.

Torsional Stiffness

Specify the torsional stiffness of the body.

Updated to match the current version of HVE.

B Stiffness Coefficient Dialog

B Stiffness Coefficients Dialog Box

The selected vehicle's stiffness coefficients are normally used for damage-based calculation methods. Choosing B Stiffness displays a dialog showing the current B-stiffness values for each crush zone. These coefficients are initially assigned by the Vehicle Editor when the vehicle is created and may be replaced by user-entered values for each crush zone. Each value may be set either with its slider or by typing directly into the edit field.

Zone 1 - 9

Enter the B-stiffness coefficient for the zone. Only the zones defined in the current damage profile are enabled; the remaining zone fields are disabled.

All Same As Zone 1

Assigns the B-stiffness coefficient of the first zone to all the zones.

Updated to match the current version of HVE.

CG To Front

CG To Front Dialog Box

The vehicle's exterior dimensions are defined by its overall length and overall width. The user may choose to edit these dimensions using the Vehicle Dimensions dialogs; the CG to Front dialog box is one among them. The distance is displayed relative to the sprung-mass CG or the total-mass CG, according to the current Vehicle Dimensions Basis selected in the user options.

x Coord

Vehicle-fixed distance from the CG to the front of the vehicle.

Front Overhang

Distance from the front axle to the front of the vehicle. This value is read-only; it is calculated and displayed by the dialog based on the entered CG-to-front distance and the front axle location.

Overall Length

This value is read-only; it is calculated and displayed by the dialog from the entered CG-to-front distance and the CG-to-back distance.

Stiffness...

Displays the stiffness dialog for the front surface. In 3-D mode this is the Vehicle Exterior Stiffness dialog; otherwise it is the Stiffness Coefficients Dialog Box (A, B and Kv). This button is disabled for Fixed Barrier and Movable Barrier vehicle types.

Apply

Applies the entered dimension to the vehicle without closing the dialog. OK applies the value and closes the dialog; Cancel reverts the vehicle to its original dimensions and stiffness.

Updated to match the current version of HVE.

CG To Back

CG To Back Dialog Box

The vehicle's exterior dimensions are defined by its overall length and overall width. The user may choose to edit these dimensions using the Vehicle Dimensions dialogs; the CG to Back dialog box is one among them. The distance is displayed relative to the sprung-mass CG or the total-mass CG, according to the current Vehicle Dimensions Basis selected in the user options.

x Coord

Vehicle-fixed distance from the CG to the back of the vehicle.

Rear Overhang

Distance from the rear axle to the back of the vehicle. This value is read-only; it is calculated and displayed by the dialog based on the entered CG-to-back distance and the rear axle location.

Overall Length

This value is read-only; it is calculated and displayed by the dialog from the entered CG-to-back distance and the CG-to-front distance.

Stiffness...

Displays the stiffness dialog for the back surface. In 3-D mode this is the Vehicle Exterior Stiffness dialog; otherwise it is the Stiffness Coefficients Dialog Box (A, B and Kv). This button is disabled for Fixed Barrier and Movable Barrier vehicle types.

Apply

Applies the entered dimension to the vehicle without closing the dialog. OK applies the value and closes the dialog; Cancel reverts the vehicle to its original dimensions and stiffness.

Updated to match the current version of HVE.

CG To Top

CG To Top Dialog Box

The vehicle's exterior dimensions are defined by its overall length, width and height. The user may choose to edit these dimensions using the Vehicle Dimensions dialogs; the CG to Top dialog box is one among them.

z Coord

Vehicle-fixed distance from the CG to the top of the vehicle.

Overall Height

This value is read-only; it is calculated and displayed by the dialog from the entered CG-to-top distance and the CG height.

Stiffness...

Displays the stiffness dialog for the top surface. In 3-D mode this is the Vehicle Exterior Stiffness dialog; otherwise it is the Stiffness Coefficients Dialog Box (A, B and Kv). This button is disabled for Fixed Barrier and Movable Barrier vehicle types.

Apply

Applies the entered dimension to the vehicle without closing the dialog. OK applies the value and closes the dialog; Cancel reverts the vehicle to its original dimensions and stiffness.

Updated to match the current version of HVE.

CG To Left

CG To Left Side Dialog Box

The vehicle's exterior dimensions are defined by its overall length and overall width. The user may choose to edit these dimensions using the Vehicle Dimensions dialogs; the CG to Left dialog box is one among them.

y Coord

Vehicle-fixed distance from the CG to the left side of the vehicle.

Overall Width

This value is read-only; it is calculated and displayed by the dialog from the entered CG-to-left distance and the CG-to-right distance.

Copy to Other Side

When checked, the entered distance (and stiffness) is also applied to the right side of the vehicle, keeping the vehicle symmetric. In HVE-2D this option is always checked and cannot be changed.

Stiffness...

Displays the stiffness dialog for the left surface. In 3-D mode this is the Vehicle Exterior Stiffness dialog; otherwise it is the Stiffness Coefficients Dialog Box (A, B and Kv). This button is disabled for Fixed Barrier and Movable Barrier vehicle types.

Apply

Applies the entered dimension to the vehicle without closing the dialog. OK applies the value and closes the dialog; Cancel reverts the vehicle to its original dimensions and stiffness.

Updated to match the current version of HVE.

CG To Right

CG To Right Side Dialog Box

The vehicle's exterior dimensions are defined by its overall length and overall width. The user may choose to edit these dimensions using the Vehicle Dimensions dialogs; the CG to Right dialog box is one among them.

y Coord

Vehicle-fixed distance from the CG to the right side of the vehicle.

Overall Width

This value is read-only; it is calculated and displayed by the dialog from the entered CG-to-right distance and the CG-to-left distance.

Copy to Other Side

When checked, the entered distance (and stiffness) is also applied to the left side of the vehicle, keeping the vehicle symmetric. In HVE-2D this option is always checked and cannot be changed.

Stiffness...

Displays the stiffness dialog for the right surface. In 3-D mode this is the Vehicle Exterior Stiffness dialog; otherwise it is the Stiffness Coefficients Dialog Box (A, B and Kv). This button is disabled for Fixed Barrier and Movable Barrier vehicle types.

Apply

Applies the entered dimension to the vehicle without closing the dialog. OK applies the value and closes the dialog; Cancel reverts the vehicle to its original dimensions and stiffness.

Updated to match the current version of HVE.

CG To Bottom

CG To Bottom Dialog Box

The vehicle's exterior dimensions are defined by its overall length, width and height. The user may choose to edit these dimensions using the Vehicle Dimensions dialogs; the CG to Bottom dialog box is one among them.

z Coord

Vehicle-fixed distance from the CG to the bottom of the vehicle.

Ground Clearance

This value is read-only; it is calculated by the dialog as the difference between the CG height (calculated from the wheel positions and tire radius) and the entered CG-to-bottom distance. For vehicles without axles (e.g., fixed barriers) the ground clearance is zero. An error message is displayed if the entered distance would produce a negative ground clearance.

Stiffness...

Displays the stiffness dialog for the bottom surface. In 3-D mode this is the Vehicle Exterior Stiffness dialog; otherwise it is the Stiffness Coefficients Dialog Box (A, B and Kv). This button is disabled for Fixed Barrier and Movable Barrier vehicle types.

Apply

Applies the entered dimension to the vehicle without closing the dialog. OK applies the value and closes the dialog; Cancel reverts the vehicle to its original dimensions and stiffness.

Updated to match the current version of HVE.

Inertia Dialog Box

Inertias Dialog Box

The suspension inertial properties for the selected wheel location are displayed and edited using this dialog box. Each value may be set either with its slider or by typing directly into the edit field.

This dialog box contains the following parameters:

Solid Axle Weight

Total weight of the axle and spring. HVE stores the corresponding mass internally; the displayed weight is calculated using the current acceleration of gravity from the Environment Editor.

Roll / Yaw Inertia

Roll and yaw inertia of the axle. Do not include wheel inertias; they are included with the tires.

Updated to match the current version of HVE.

Moving CG

Move CG Dialog

The default CG (center of gravity) location of the vehicle is determined from raw data (e.g., measured or table values). The user may choose to edit the CG location using the Move CG dialog. The entered offsets are displayed relative to the sprung-mass CG or the total-mass CG, according to the current Vehicle Dimensions Basis selected in the user options.

This dialog box contains the following items:

Change Dx

Moves the CG in the +x or -x direction, relative to the vehicle-fixed coordinate system (+x is forward in the SAE coordinate system).

Change Dy

Moves the CG in the +y or -y direction, relative to the vehicle-fixed coordinate system (+y is to the right in the SAE coordinate system). In HVE-2D this field is read-only.

Change Dz

Moves the CG in the +z or -z direction, relative to the vehicle-fixed coordinate system (+z is down in the SAE coordinate system).

CG Height

Approximate CG height, calculated from the vehicle wheel positions and the tire radius. Tire deflection is ignored. This field is read-only.

Apply

Applies the entered CG movement to the vehicle without closing the dialog, so the effect can be inspected. OK applies the movement and closes the dialog.

Updated to match the current version of HVE.

Payload Dialog Box

Payload Dialog Box

The Payload dialog allows the user to add a payload to the selected vehicle. The payload may be any object adding inertia to a vehicle that is not accounted for in the vehicle's inertial properties. Which payload fields may be edited depends on the physics options of the calculation method assigned to the current event; fields not supported by the current calculation method are disabled.

Payload Exists

Check this box if the vehicle has a payload. When unchecked, all remaining fields are disabled and the payload is ignored.

x

The X distance from the vehicle's center of gravity to the payload's center of gravity.

y

The Y distance from the vehicle's center of gravity to the payload's center of gravity.

z

The Z distance from the vehicle's center of gravity to the payload's center of gravity.

Weight

The weight of the payload.

Mass

The mass of the payload. This field is read-only; it is calculated as the entered weight divided by the current acceleration of gravity.

Roll

The roll moment of inertia of the payload.

Pitch

The pitch moment of inertia of the payload.

Yaw

The yaw moment of inertia of the payload.

Updated to match the current version of HVE.

Sprung Mass Dialog

Sprung Mass Dialog Box

Clicking on the CG of the vehicle in the Vehicle Editor allows the user to edit the sprung mass parameter groups. Each button opens the dialog for the corresponding parameter group.

This dialog contains the following items:

Inertias...

Displays the Vehicle Inertia Dialog Box.

Move CG...

Displays the Move CG Dialog Box.

Color...

The color of the vehicle is obvious from looking at it. The color may be edited using the Color dialog.

Geometry File...

The current vehicle may be visualized using a simplified vehicle shape or an actual 3-D geometry file created by digitizing the vehicle. If a 3-D geometry file is available for the current vehicle, it may be selected and displayed. (In HVE-2D this button is labeled **Exterior Geometry...**.)

Refresh Geometry File

Reloads the current 3-D geometry file from disk, picking up any changes made to the file outside of HVE.

Transform Geometry...

Displays the Transform Geometry dialog, used to translate, rotate or scale the vehicle's 3-D geometry. This button is available only when the vehicle uses a complex (file-based) geometry.

Contact Surfaces...

Displays the Contact Surfaces Dialog Box. (Not available in HVE-2D.)

Belt Restraints...

Displays the Belt Restraints Dialog Box. (Not available in HVE-2D.)

Airbag Restraints...

Displays the Airbag Restraints Dialog Box. (Not available in HVE-2D.)

Connections...

Displays the Inter-Vehicle Connections Dialog Box.

Aerodynamic Drag...

Displays the Aerodynamic Drag Dialog Box. (Not available in HVE-2D.)

Body Torsion...

Displays the Body Torsion Dialog Box. (Not available in HVE-2D.)

Handling...

Displays the Handling Properties dialog, a read-only summary of the vehicle's calculated handling parameters: total understeer gradient, steering wheel sensitivity, roll gradient, roll couple distribution, weight distribution, and static front/rear tire weights.

Report Color...

Edits the color used to represent this vehicle in reports.

Lights...

Displays the Lights dialog, used to configure the vehicle's lamps for visualization.

Updated to match the current version of HVE.

Stiffness Coefficient Dialog

Stiffness Coefficients Dialog Box

The vehicle's structural properties are defined by its stiffness coefficients. The user may choose to edit these coefficients for the front, back, sides, top or bottom of the vehicle using this dialog; the dialog title shows which surface is being edited (Front, Right Side, Rear, Left Side, Top or Bottom). Each value may be set either with its slider or by typing directly into the edit field.

Note: This dialog is used when HVE is running in 2-D mode. In 3-D mode, the Stiffness buttons in the Vehicle Dimensions dialogs open the Vehicle Exterior Stiffness dialog instead, which additionally supports 3-D (constant/linear/quadratic/cubic) stiffness definitions, saturation crush and maximum crush.

Stiffness Coefficient A

Assigns the force per unit of damage width required to initiate permanent crush.

Stiffness Coefficient B

Assigns the linear spring rate (force vs. deflection constant) per unit of damage width required to produce permanent crush.

Stiffness Coefficient Kv

Assigns the linear spring rate (force vs. deflection constant) per unit of damage width required to produce permanent crush. This value differs from the B constant in that it assumes the force vs. deflection graph goes through zero.

Updated to match the current version of HVE.

Vehicle Drag Dialog

Vehicle Drag (Aerodynamic Drag) Dialog Box

The vehicle drag associated with aerodynamic pressure. The Aerodynamic Drag dialog allows the user to view or edit these properties for each of the vehicle's aerodynamic surfaces. Each surface stores its own complete set of coefficients and center-of-pressure data.

Surface

Selects the surface whose data is displayed. Available surface options are:

- Front
- Right
- Back
- Left
- Top
- Bottom
- FrontDevice
- BackDevice

Device Installed

Switch that activates the selected surface. When unchecked, most of the fields for that surface are disabled (the coefficient fields and the Center of Pressure X and Y fields); the Projected Surface Area edit and the Center of Pressure Z label remain enabled. The surface produces no aerodynamic force.

Drag Coefficient

Assigns the properties resisting motion due to dynamic air pressure acting on the selected surface in the direction of the vehicle's total velocity vector. The force associated with this pressure is proportional to the velocity squared.

Lift Coefficient

Assigns the properties resisting motion due to dynamic air pressure acting on the selected surface in the direction normal (vertical) to the vehicle's total velocity vector.

Side Coefficient

Assigns the properties resisting motion due to dynamic air pressure acting on the selected surface in the lateral direction, normal to the vehicle's total velocity vector.

Projected Surface Area

Assigns the projected area parallel to the selected surface.

Center of Pressure X

Vehicle-fixed X coordinate where the effective force from aerodynamic pressure is applied.

Center of Pressure Y

Vehicle-fixed Y coordinate where the effective force from aerodynamic pressure is applied.

Center of Pressure Z

Vehicle-fixed Z coordinate where the effective force from aerodynamic pressure is applied.

Note: The center-of-pressure coordinates are displayed relative to the sprung-mass CG or the total-mass CG, according to the current Vehicle Dimensions Basis selected in the user options.

Updated to match the current version of HVE.

Getting Information about the Vehicle

Vehicle Information Dialog Box

New vehicles are added to the current case using the Vehicle Editor, and the properties of the selected vehicle can be viewed and edited using the Vehicle Information dialog box. The Make, Model, Year, Body Style and Source Database lists are filled from the installed vehicle databases; each selection filters the choices available in the lists below it.

This dialog box contains the following items:

Vehicle Name

A user-editable field allowing the user to assign a name to the current vehicle. If no name is entered, a default name is generated from the vehicle's year, make and model.

Vehicle Type

Defines the basic vehicle type. Only types actually present in the installed vehicle databases are listed. The possible selections are:

- Passenger Car
- Pickup
- Sport-Utility
- Van
- Truck
- Trailer
- Dolly
- Fixed Barrier
- Movable Barrier

Wizard...

Starts the Vehicle Wizard for building a custom vehicle. The button is enabled for Passenger Car, Pickup, Sport-Utility, Van, Truck, Trailer and Dolly types having 1 to 3 axles; it is disabled for Fixed and Movable Barriers.

Make

Vehicle manufacturer, chosen from the manufacturers available in the database for the selected vehicle type.

Model

Vehicle model, chosen from the models available for the selected make.

Year

Model year, chosen from the years available for the selected model.

Body Style

Vehicle body style (e.g., 2-Dr Hardtop, 4-Dr Sedan, etc.), chosen from the styles available for the selected year.

Source Database

The vehicle database file that supplies the selected vehicle's data (e.g., the EDC database or the user database). Displays "Unknown" if the source cannot be determined.

Number of Axles

Allowable selections are None, One, Two or Three. For a Fixed Barrier, the only selection is None.

Driver Location

Allowable selections are None, Left, Center or Right.

Engine Location

Allowable selections are None, Front, Mid or Rear.

Drive Axle(s)

Allowable selections depend on the number of axles: None; Axle No. 1; Axle No. 2; Axle No. 3; Axle Nos. 1 and 2; Axle Nos. 2 and 3; or Axle Nos. 1, 2 and 3.

Save As...

Allows the user to save the current vehicle to the user vehicle database, either overwriting an existing entry with the same keys or creating a new entry. It displays the Save As New Vehicle dialog box.

Delete

Removes the selected vehicle from its source database file after a confirmation prompt. Use with care; the vehicle entry is permanently removed from the database.

Updated to match the current version of HVE.

Vehicle Inertia Dialog

Vehicle Inertia Dialog Box

The inertial properties of the vehicle are displayed and edited using the Vehicle Inertia dialog. The dialog now displays two columns of values — **Total** (total vehicle) and **Sprung** (sprung mass only) — and keeps them consistent: editing a value in one column automatically recalculates the corresponding value in the other column using the vehicle's unsprung (axle/wheel) masses and their locations.

This dialog box contains the following parameters:

Weight (Total / Sprung)

Vehicle weight. HVE calculates and stores mass by dividing the entered weight by the current acceleration of gravity (set in the Environment Editor). Entering a Total weight updates the Sprung weight, and vice versa.

Mass (Total / Sprung)

Vehicle mass (weight/g), the value actually stored by the Vehicle Editor. These fields are read-only; they are recalculated whenever a weight is edited.

Rotational Inertia — Roll (Total / Sprung)

Rotational inertia about the X axis. The Sprung value is the value stored with the vehicle; the Total value includes the unsprung masses.

Rotational Inertia — Pitch (Total / Sprung)

Rotational inertia about the Y axis.

Rotational Inertia — Yaw (Total / Sprung)

Rotational inertia about the Z axis.

XZ Product of Inertia (Sprung only)

Inertial product about the Y axis. This value represents the fact that the x-z plane is not a plane of symmetry for the vehicle sprung mass.

Basic... / Complex...

Toggles the dialog between the Basic view (Sprung column only, dialog narrowed) and the Complex view (both Total and Sprung columns). The last-used state is remembered between sessions.

Auto Update When Weight Changes

When checked, the rotational inertias are automatically rescaled in proportion to the change whenever the vehicle weight is edited, so the inertias remain consistent with the new mass. The setting is remembered between sessions.

Apply

Applies the current values to the vehicle without closing the dialog. OK applies the values and closes the dialog; Cancel discards unapplied changes.

Note for HVE-2D users: In HVE-2D the Roll, Pitch and XZ Product fields are read-only, the Total column and the Basic/Complex button are hidden, and only the Yaw inertia may be edited.

Updated to match the current version of HVE.

Saving Vehicles

Save As New Vehicle Dialog Box

New vehicles may be added to the user vehicle database (user.db), thus extending the vehicle library. When OK is chosen, the vehicle is written to the user database using the keys entered below. If a vehicle with the same Type/Make/Model/Year/Body Style keys already exists, the user is asked whether to overwrite it. After saving, the vehicle database is rebuilt and the saved vehicle becomes the current vehicle.

This dialog box contains the following items:

Vehicle Type

The basic type of the vehicle being saved (Passenger Car, Pickup, etc.). This field is read-only; the type is inherited from the current vehicle.

Make

Specify the vehicle manufacturer.

Model

Specify the vehicle model.

Year

Specify the model year.

Body Style

Specify the vehicle body style (e.g., 2-Dr Hardtop, 4-Dr Sedan, etc.).

Security Key

Specify the security key for the vehicle. This key may be used to restrict access to proprietary vehicle data.

Version Information

Specify version information for the vehicle. This text is stored with the vehicle's database entry so revisions of the same vehicle can be identified.

Geometry File Name

The current vehicle may be visualized using a simplified vehicle shape or an actual 3-D geometry file created by digitizing the vehicle. If a 3-D geometry file is available for the current vehicle, its file name may be entered here and is

stored with the saved vehicle.

Updated to match the current version of HVE.

Suspension & Steering

Dialog and feature reference for the HVE **Suspension & Steering** area, converted from the on-line help and verified against the current release. Part of the HVE Manual.

Pages

- Anti-Pitch Dialog
- Camber vs Jounce/Rebound Dialog
- Jounce and Rebound Stops Dialog
- Roll Steer Dialog
- Roll Steer Properties
- Spindle Axis Dialog
- Springs and Shocks Dialog
- Steering System Dialog
- Suspension Data Dialog
- Wheel Location Dialog

Anti-Pitch Dialog

The Anti-Pitch properties for the selected wheel location are displayed and edited using this dialog box. Anti-pitch data are entered as a table of anti-pitch coefficient vs. suspension deflection. This dialog is available only when the suspension type is **Independent** (the Anti-Pitch button on the Suspension Data dialog is disabled for solid and tandem axles).

The dialog title identifies the current axle and side.

Anti-Pitch Graph

Graph titled

Anti-Pitch vs. Jounce/Rebound

, plotting the anti-pitch coefficient against suspension jounce/rebound deflection using the values in the data grid.

Data Grid

Table of anti-pitch data with two columns:

- **Jounce/Rebound (in)** — Suspension deflection (jounce negative, rebound positive).
- **Anti-Pitch (lb/ft-lb)** — Anti-pitch coefficient at that deflection.

Rows may be entered in any order; on Apply or OK the table is sorted by deflection and empty rows are removed. Each row must be complete, and duplicate deflection values are rejected.

Apply

Validates the grid data and redraws the graph with the supplied data.

Print

Prints the displayed graph.

Updated to match the current version of HVE.

Camber vs Jounce/Rebound Dialog

The camber and half-track properties for the selected wheel location are displayed and edited using this dialog box. This dialog is used for **independent** suspensions; for solid and tandem axles the Camber button on the Suspension Data dialog opens a small dialog containing a single constant *Camber (deg)* value instead.

The dialog title identifies the current axle and side.

Camber Graph

The upper graph, titled

Camber vs. Jounce/Rebound

, plots the wheel camber angle (deg) against suspension jounce/rebound deflection (in), using the values in the data grid.

Half-Track Change Graph

The lower graph, titled

Half-track Change vs. Jounce/Rebound

, plots the half-track change (in) against suspension jounce/rebound deflection (in), using the values in the data grid.

Data Grid

Table of camber data with three columns:

- **Jounce/Rebound (in)** — Suspension deflection (jounce negative, rebound positive).
- **Wheel Camber (deg)** — Camber angle at that deflection.
- **Half-track Change (in)** — Lateral movement of the wheel at that deflection.

Rows may be entered in any order; on Apply or OK the table is sorted by deflection and empty rows are removed. Each row must be complete (a row with missing entries produces an error), and duplicate deflection values are rejected.

Apply

Validates the grid data and redraws both graphs with the given data.

Print

Prints the displayed graphs.

Updated to match the current version of HVE.

Jounce and Rebound Stops Dialog

The Jounce and Rebound stop properties for the selected wheel location are displayed and edited using this dialog box. The dialog title identifies the current axle and side.

Separate stop data are stored for jounce and for rebound; the two radio buttons at the top select which stop's parameters are displayed in the fields below.

Suspension Stop

Jounce (Compression) Selects the jounce (compression travel limit) stop for display and editing.

Rebound (Extension) Selects the rebound (extension travel limit) stop for display and editing.

Stop Parameters

Max Deflection to Jounce Stop / Max Deflection to Rebound Stop (in) Suspension travel distance from equilibrium to the selected stop. The field label changes with the selected stop; jounce deflections are entered as negative values (compression) and rebound deflections as positive values (extension).

Linear Deflection Rate of Stop (lb/in) Linear constant (force per unit of wheel travel) of the selected suspension stop.

Cubic Deflection Rate of Stop (lb/in^3) Cubic constant (force per unit of wheel travel cubed) of the selected suspension stop.

Energy Ratio of Stop (%/100) Ratio of conserved to total energy (restitution) of the selected suspension stop, between 0 and 1.

Updated to match the current version of HVE.

Roll Steer Dialog

The Roll Steer properties for the selected wheel location are displayed and edited using this dialog box. This dialog is used for **independent** suspensions; for solid and tandem axles the single-coefficient Roll Steer Properties dialog is displayed instead.

The dialog title identifies the current axle and side.

Roll Steer Graph

Graph titled

Roll Steer vs. Jounce/Rebound

showing the wheel steer angle produced by the polynomial coefficients below, plotted against suspension jounce/rebound deflection.

Roll Steer Constant Coef (deg)

Initial steer angle at zero suspension deflection (constant term of the polynomial).

Roll Steer Linear Coef (deg/in)

Linear coefficient of roll steer vs. jounce/rebound deflection.

Roll Steer Quadratic Coef (deg/in^2)

Quadratic coefficient of roll steer vs. jounce/rebound deflection.

Roll Steer Cubic Coef (deg/in^3)

Cubic coefficient of roll steer vs. jounce/rebound deflection.

Apply

Redraws the graph using the currently entered coefficients.

Print

Prints the displayed graph.

Updated to match the current version of HVE.

Roll Steer Properties

The Roll Steer properties for the selected wheel location are displayed and edited using this dialog when the suspension type is **Solid Axle** or one of the tandem types. (For independent suspensions the full Roll Steer Dialog Box with polynomial coefficients is displayed instead.)

The dialog title identifies the current axle (e.g.,

Roll Steer: Axle No. 2 (Solid Axle)

).

This dialog contains the following item:

Roll Steer Coefficient (deg/deg)

User-editable roll steer coefficient: the ratio of wheel (axle) steer angle to body roll angle.

Updated to match the current version of HVE.

Spindle Axis Dialog

The spindle axis geometry properties for the selected wheel location are displayed and edited using this dialog box. The dialog is available only for steerable axles (the Spindle Axis button on the Suspension Data dialog is disabled otherwise). The dialog title identifies the current axle and side.

This dialog box contains the following parameters:

Alignment

Caster (deg) The fore-aft angle of the spindle axis. This angle is largely responsible for the self-aligning properties of a steerable axle.

King Pin Inclination (deg) The sideways angle of the spindle axis. This angle, along with the caster angle, is responsible for the self-aligning properties of the steerable axle.

Steering Offset (in) The distance from the center of the tire contact patch to the point where the steering axis intersects the ground at equilibrium conditions. This distance produces a steering torque (positive or negative, depending on the sign of the scrub radius) due to longitudinal tire force (either braking or driving).

Stub Axle Length (in) The length of the stub axle (spindle) from the steering axis to the wheel plane.

(This parameter was added since the original help topic was written.)

Toe-In (in) The difference in distance between the center of the tire plane at the spindle and the front of the tire.

Steer Axis Friction Torque (ft-lb) Constant (coulomb) friction torque about the steer axis. Rotation of the wheel about the steering axis is resisted by this torque, which must be overcome before the wheel steers.

(The original help left this entry blank; the description above is derived from the code.)

Steering Stops

Separate stop data are stored for right and left steer; the two radio buttons select which stop's parameters are displayed in the fields below.

Steering: Right (+) Selects the right (positive) steering stop for display and editing.

Steering: Left (−) Selects the left (negative) steering stop for display and editing.

Stop Angle (deg) The vehicle-fixed steering angle at which the stop is reached.

Stop Linear Stiffness (ft-lb/deg) The mechanical stiffness of the steering stop. Additional steering beyond the stop angle is resisted by a torque that attempts to return the wheel towards zero steer.

Stop Energy Ratio The ratio of conserved to total energy of the selected steering stop, between 0 and 1 (this property is analogous to the Jounce and Rebound stop energy ratio). This parameter keeps the wheel from bouncing off the steering stop.

Updated to match the current version of HVE.

Springs and Shocks Dialog

The Springs and Shocks properties for the selected wheel location are displayed and edited using this dialog box. The dialog title identifies the current axle and side.

This dialog box contains the following parameters:

Springs

Wheel Rate (lb/in) Spring rate (force per unit of wheel travel) at the selected wheel due to the spring.

Aux. Roll Stiffness (in-lb/deg) Roll stiffness (torque per unit of sprung mass roll) added by the addition of an anti-sway bar.

Roll Center Height (in) Vertical distance from the sprung mass CG down (+) to the suspension roll center. Applies to solid axles only; the field is disabled when the suspension type is *Independent*.

Lateral Spring Spacing (in) Lateral distance between the left and right suspension springs of a solid axle; together with the ride rate it determines the axle's roll stiffness. Applies to solid axles only; the field is disabled when the suspension type is *Independent*.

(The original help mislabeled this field "Lateral Space Spring" and described it incorrectly; the label and description above match the current code.)

Shock Absorbers

Damping at Wheel (lb-sec/in) Velocity-dependent suspension force due to shock absorbers.

Coulomb Friction (lb) Friction force required to initiate suspension travel.

Friction Null Band (in/sec) Minimum suspension velocity required for full coulomb friction force.

Updated to match the current version of HVE.

Steering System Dialog

The steering system parameters for the current vehicle are displayed and edited using the Steering System dialog. The dialog title identifies the current vehicle.

The Steering System parameters are:

Steering Data For

Selects the axle whose steering data you want to view or modify (*Axle No. 1*, *Axle No. 2* or *Axle No. 3*, limited by the number of axles defined in the Vehicle Information dialog).

Steerable Axle

Check box to allow or disallow steering at the selected axle. When unchecked, all of the parameter fields below are disabled for that axle, and the Spindle Axis button in the Suspension Data dialog is disabled for that axle as well.

Steering Gear Ratio (deg/deg)

Ratio of the steering wheel angle to the road wheel steer angle.

Steering Column Friction (in-lb)

Friction torque measured at the steering wheel.

Steering Column Inertia (lb-sec^2-in)

Rotational inertia of the steering wheel and column.

Steering Column Stiffness (ft-lb/deg)

Torsional stiffness of the steering system between the steering wheel and the wheel on the driver's side.

Steering Linkage Mass (lb-sec^2/in)

Mass (weight/g) of all translating linkage components.

Steering Linkage Stiffness (ft-lb/deg)

Torsional stiffness of the steering system between the driver's-side wheel and the opposite-side wheel.

Steering Linkage Damping (lb-sec/in)

Linear damping of the linkage system.

Steering Friction Lag (deg/sec)

Rotational velocity required to develop the full steering friction torque.

Updated to match the current version of HVE.

Suspension Data Dialog

The suspension parameters of the vehicle are displayed and edited using the Suspension Data dialog. The dialog title identifies the current vehicle, axle number and side (e.g.,

Suspension Data: ... (Axle No. 1, Left Side)

).

This dialog contains the following items:

Suspension Type

The HVE Vehicle Model includes the following suspension types:

- **Independent** — The right and left wheels move independently from each other.
- **Solid Axle** — The right and left wheels are rigidly connected.
- **Tandem 4 Spring** — A set of two solid axle suspensions sharing an articulated spring support, such that the force on the rear of the leading spring is transferred to the front of the trailing spring.
- **Tandem Walking** — A set of two solid axle suspensions connected by a rigid link.

The tandem types are offered in the list only where a tandem axle set is possible: on rear axles of vehicles with more than two axles, and on trailers or dollies with more than one axle. Otherwise the list contains only *Independent* and *Solid Axle*.

The selected type also controls which of the buttons below are available (see individual entries).

Lateral Load Transfer Coef (%/100)

Slider/edit field for the fraction of the total sprung mass roll couple (lateral load transfer) reacted at the selected axle. Values at the individual axles are automatically balanced so that the distribution over all axles totals 1.0 (for example, changing the value at a rear axle adjusts the front axle share accordingly; on three-axle vehicles the remainder is split between the other axles). The controls are disabled if the vehicle has fewer than two axles, or if the vehicle has no driver location defined (except movable barriers).

(This option was added since the original help topic was written.)

Inter-Tandem Load Transfer Coef (%/100)

If the selected suspension type is a tandem axle (either *4-Spring* or *Walking Beam*), the Inter-tandem Load Transfer parameter is enabled, allowing the user to enter a value for the inter-tandem load transfer for the selected axle set. For *Independent* and *Solid Axle* types this field is disabled.

Mechanical Group

Springs and Shocks... Displays the Springs and Shocks Dialog Box.

Inertia... (Axle Inertia) Displays the Inertia dialog box (solid axle weight and roll/yaw inertia). Enabled only when the suspension type is *not* Independent.

Jounce/Rebound... Displays the Jounce/Rebound Stops Dialog Box.

Geometry Group

Spindle Axis... Displays the Spindle Axis Dialog Box. Enabled only if the current axle is steerable (see the Steering System dialog).

Camber... Displays the Camber Dialog Box. For *Independent* suspensions this opens the full Camber vs. Jounce/Rebound table/graph dialog; for solid and tandem axles it opens a small dialog containing a single constant *Camber (deg)* value.

Anti-Pitch... Displays the Anti-Pitch Dialog Box. Enabled only when the suspension type is *Independent*.

Roll Steer... Displays the Roll Steer dialog. For *Independent* suspensions this is the Roll Steer Dialog Box (constant/linear/quadratic/cubic coefficients vs. jounce/rebound); for solid and tandem axles it is the single-coefficient Roll Steer Properties dialog.

Copy to Other Side

Check this box to copy all the suspension properties of this wheel to the wheel on the other side of the same axle when you click OK.

Copy to Other Axle(s)

Check this box to copy the suspension properties of this axle to the vehicle's other axle(s) when you click OK.

(This option was added since the original help topic was written.)

Updated to match the current version of HVE.

Wheel Location Dialog

The wheel location coordinates relative to the vehicle-fixed coordinate system are displayed and edited using the Wheel Location dialog box. The dialog title identifies the current axle and side.

This dialog box contains the following parameters:

Coordinates x (in)

The longitudinal distance from the vehicle CG to the selected wheel (positive forward).

Coordinates y (in)

The lateral distance from the vehicle CG to the selected wheel (positive toward the right side).

Coordinates z (in)

The vertical distance from the vehicle CG to the selected wheel (positive downward). In HVE-2D (when the simplified 2D vehicle data dialogs are active) this field is read-only.

Copy To Other Side

Copies the current settings to the wheel on the other side of the same axle when you click OK. In HVE-2D this box is always checked and cannot be changed, so both wheels of the axle are always updated together.

Updated to match the current version of HVE.

Brakes & Powertrain

Dialog and feature reference for the HVE **Brakes & Powertrain** area, converted from the on-line help and verified against the current release. Part of the HVE Manual.

Pages

- Brake Assembly Dialog Box
- Brake Designer Material Properties Dialog Box
- Brake Designer Single Piston Dialog Box
- Brake System Pressure vs Pedal Force Dialog Box
- Differential Data Dialog Box
- Disk Brake Dialog Box
- Drive Train Dialog Box
- Dual Piston Brake Dialog Box
- Dual Wedge Brake Dialog Box
- Duo Servo Brake Dialog Box
- Duplex Brake Dialog Box
- Transmission Data Dialog Box

Brake Assembly Dialog Box

The Brake Assembly properties for the selected wheel are displayed and edited using this dialog box.

This dialog box contains the following parameters.

Time Lag (sec)

Time required before the driver's brake pedal inputs reach the wheel.

Time Rise (sec)

Time required for the brake system pressure at the wheel to begin causing the maximum brake torque as specified by the Brake Torque Ratio.

Brake Assembly Type

An option list displaying the type of brake assembly used at the selected wheel location. The default is Generic. In this case, the Brake Torque Ratio is defined directly by the user. The other types are Disc, Duo-Servo, Duplex, Single Piston, Dual Piston, S-Cam, Single Wedge, Dual Wedge and Air Disc.

Edit ...

Opens the Brake Designer dialog for the currently selected Brake Assembly Type, allowing the physical brake components to be edited. This button is disabled when the Generic type is selected. When a specific brake design is used, the Push-out Pressure and Brake Torque Ratio are computed by the Brake Designer; selecting Disc or Air Disc also sets the wheel brake assembly type for the axle to Disc, while the drum-based designs set it to Drum.

Push-out Pressure (psi)

Brake system pressure required to begin causing brake torque (any system pressure below this point is simply taking out the slack in the system). User-editable for the Generic type; computed by the Brake Designer for the other types.

Brake Torque Ratio (in-lb/psi)

Wheel brake torque per unit of system pressure at the wheel. The actual braking torque at the wheel is the product of the current wheel system pressure and the Brake Torque Ratio. User-editable for the Generic type; computed by the Brake Designer for the other types.

Proportion On

Click on the check box if the system pressure at the selected wheel is reduced by a proportioning value.

Pstart (psi)

Beginning at this level of system pressure, any additional master cylinder pressure will be reduced.

Ratio

At master cylinder pressure above the Proportioning Starting Pressure, additional pressure is reduced by this ratio.

Simple Antilock On

Click on this check box if the selected wheel has a simple (functional) anti-lock device installed. Checking this option enables the Antilock Effectiveness control. The simple antilock controls are available when ABS Installed has been selected in the Brake System Pressure vs Pedal Force dialog.

Antilock Effectiveness (%/100)

The ability of the anti-lock system to achieve and hold the selected wheel at its peak frictional force, even if the driver braking input exceeds the available frictional force. A 100% effective anti-lock system maintains a longitudinal wheel force associated with the peak coefficient of friction. A 0% effective system maintains a longitudinal wheel force associated with the slide coefficient of friction. A 50% effective system would maintain a longitudinal force halfway between that associated with peak and slide friction.

ABS Designer...

Opens the ABS Designer dialog, used to edit the detailed ABS wheel data (wheel kinematics thresholds such as minimum velocity, tire slip range and spin acceleration range, and pressure modulation parameters such as cycle rate, apply/release delays and apply/release rates) for the selected wheel. This button is enabled only when ABS Installed has been selected in the Brake System Pressure vs Pedal Force dialog.

(New option; not documented in the previous manual.)

Copy to Other Side

Check this check box if you want all the properties set for this wheel to be copied to the wheel on the other side of the same axle.

Copy to Other Axles

Check this check box if you want all the properties set for this wheel to be copied to the wheels on the other axles.

(New option; not documented in the previous manual.)

Updated to match the current version of HVE.

Brake Designer Material Properties Dialog Box

This dialog box displays the material properties used by the Brake Designer for thermal calculations. It is opened by pressing the Material ... button in any of the Brake Designer dialogs. The properties are divided into two groups: Rotor/Drum Properties and Lining Properties.

Rotor/Drum Properties

Density (lb/ft^3) Density of rotor or drum material (used for calculating the mass of the rotor or drum).

Specific Heat (in-lb/lb-deg F) Change in enthalpy of the brake rotor or drum material with respect to temperature at constant pressure.

Conduction Coefficient (in-lb/in^2-hr-deg F-in) Energy transfer coefficient through the brake rotor or drum material.

Convection Coefficient (in-lb/in^2-hr-deg F) Static convective energy transfer coefficient between the brake rotor or drum surface and adjacent air.

Velocity Dependence (in-lb-sec/in^2-hr-deg F-in) Velocity-dependent energy transfer coefficient between the brake rotor or drum surface and adjacent air (i.e., this coefficient is multiplied by vehicle linear velocity to determine the convection rate).

Lining Properties

Density (lb/ft^3) Density of lining material (used for calculating the mass of the pads or shoe lining).

Specific Heat (in-lb/lb-deg F) Change in enthalpy of the brake lining material with respect to temperature at constant pressure.

Conduction Coefficient (in-lb/in^2-hr-deg F-in) Energy transfer coefficient through the brake lining material.

Convection Coefficient (in-lb/in^2-hr-deg F) Static convective energy transfer coefficient between the brake lining surface and adjacent air.

Velocity Dependence (in-lb-sec/in^2-hr-deg F-in) Velocity-dependent energy transfer coefficient between the brake lining surface and adjacent air (i.e., this coefficient is multiplied by vehicle linear velocity to determine the convection rate).

Updated to match the current version of HVE.

Brake Designer Single Piston Dialog Box

This Brake Designer dialog (Single Piston, Leading/Trailing Shoe) is used to edit the physical parameters of a single-piston drum brake in which one wheel cylinder actuates a leading (primary) shoe and a trailing (secondary) shoe. Because some single-piston wheel cylinders use different piston areas on each end, the actuation force is calculated separately for the primary and secondary shoes. The dialog includes a schematic preview drawing of the brake, updated to reflect the current dimensions.

Wheel Cylinder

Area, Primary Piston (in^2) Cross-sectional area of the wheel cylinder piston acting on the primary (leading) shoe.

Area, Secondary Piston (in^2) Cross-sectional area of the wheel cylinder piston acting on the secondary (trailing) shoe.

Push-out Pressure (psi) Pressure required to overcome the force associated with the return springs and begin developing brake torque.

Shoe/Drum

Drum Diameter (in) Inside diameter of the brake drum.

Drum Lining Width (in) Width of the lining material (and drum friction surface).

Drum Thickness (in) Thickness of the drum wall (used for calculating the thermal mass of the drum).

Lining (Primary and Secondary columns)

The following parameters are entered separately for the primary (Pri) and secondary (Sec) shoes.

Lining Arc Length (in) Length of the lining material along the arc of contact with the drum.

Lining Alph 1 (deg) (labeled *Lining Alph 1* in the dialog — a UI typo for *Lining Alpha 1*) Angle locating the leading edge of the lining relative to the shoe actuation axis.

Lining Thickness (in) Thickness of the lining material.

Shoe Pin Radius (in) Radial distance from the center of the brake to the anchor pin for pinned brake shoes. (The secondary shoe value follows the primary and is not directly editable.)

Shoe lock Length (in) (labeled *Shoe lock Length* in the dialog — a UI typo for *Shoe Block Length*) Length of the shoe abutment block. (The secondary shoe value follows the primary and is not directly editable.)

Mechanical Efficiency Fraction of the actuation force actually delivered to the shoes after mechanical (friction and linkage) losses.

Buttons and Results

Friction ... Opens the Lining Friction Properties dialog, used to edit the lining friction coefficient as a function of lining temperature for the primary and secondary linings.

Material ... Opens the Brake Designer Material Properties dialog, used to edit the drum and lining material thermal properties.

Apply Recomputes the results below from the current physical parameters.

Brake Factor *(read-only)* Calculated ratio of total drum drag force to actuation force for the brake.

Actuation Factor *(read-only)* Calculated actuation force per unit of system pressure.

Brake Torque Ratio (in-lb/psi) *(read-only)* Calculated wheel brake torque per unit of system pressure. On pressing OK, this value replaces the Brake Torque Ratio in the Brake Assembly dialog.

Updated to match the current version of HVE.

Brake System Pressure vs Pedal Force Dialog Box

The Brake System parameters for the current vehicle are displayed and edited using this dialog box.

This dialog box contains the following items:

Brake System Type

Radio buttons selecting the type of brake system installed on the vehicle: **Hydraulic** or **Air**. *(New option; not documented in the previous manual.)*

Wheel Brake Assembly

This group displays and edits the brake assembly type installed on each axle.

(New group; not documented in the previous manual.)

Axle Number Drop-down list selecting the axle (1 up to 3, depending on the number of axles on the current vehicle) whose brake assembly type is displayed.

Brake Assembly Type Radio buttons selecting **Disc** or **Drum** for the selected axle. Note that this setting is also updated automatically when a specific brake design is chosen in the Brake Assembly dialog (Disc and Air Disc designs set it to Disc; drum-based designs set it to Drum). A warning message is issued when the dialog opens if the right and left brake types on an axle are different, as this is probably a mistake.

ABS Installed

Check this box if the vehicle is equipped with an anti-lock brake system. Checking this option enables the Edit... button and enables the antilock options in the Brake Assembly dialog.

(New option; not documented in the previous manual.)

Edit...

Opens the ABS System Data dialog, used to edit the system-level ABS parameters: control source, ABS algorithm, control method, cycle rate, ABS pressure threshold, ABS velocity threshold, low friction threshold, and delay parameters (delay method, apply delay and release delay). Enabled only when ABS Installed is checked.

(New option; not documented in the previous manual.)

Pedal Ratio (psl / lb) *(labeled "psl / lb" in the dialog — a UI typo for psi/lb)*

Ratio of master cylinder pressure per unit of brake pedal force. This control is disabled if the current vehicle has no driver.

Updated to match the current version of HVE.

Differential Data Dialog Box

The HVE vehicle differential is modeled by up to 3 ratios. The differential is edited using the Differential Data dialog, opened from the Drivetrain dialog.

This dialog box contains the following items:

Gears

Drop-down list selecting the number of differential (final drive) ratios: 1, 2 or 3 speeds.

Gear Data Grid

This data grid contains one row per differential speed and the following columns:

- **Gear** — Name of each differential speed (High, and depending on the number of gears, Med and Low). This column is read-only.
- **Ratio** — Final drive ratio for each speed.

Type

Radio buttons for the differential type: **Standard** (open), **Limited Slip** and **Locked**. These options are currently disabled: the HVE drivetrain model assumes an open (standard) differential, and Limited Slip and Locked are not yet implemented, so Standard is always selected. *(New group; not documented in the previous manual.)*

Updated to match the current version of HVE.

Disk Brake Dialog Box

This Brake Designer dialog is used to edit the physical parameters of a hydraulic disc (caliper) brake. The dialog includes a schematic preview drawing of the brake, updated to reflect the current dimensions.

Caliper

Number of Pistons Drop-down list selecting the number of caliper pistons (1, 2 or 3).

Piston Diameter (in) Diameter of each caliper piston.

Push-out Pressure (psi) Pressure required to overcome the caliper seal/return force and begin developing brake torque.

Rotor

Outside Diameter (in) Outside diameter of the rotor.

Inside Diameter (in) Inside diameter of the rotor swept (friction) surface.

Rotor Thickness (in) Thickness of the rotor (used for calculating the thermal mass of the rotor).

Lining (Inner and Outer columns)

The following parameters are entered separately for the inner and outer pads.

Pad Thickness (in) Thickness of the pad lining material.

Incl. Angle (deg) Included angle of the pad (the arc of the rotor surface covered by the pad).

Mechanical Efficiency Fraction of the actuation force actually delivered to the pads after mechanical losses.

Buttons and Results

Friction ... Opens the Lining Friction Properties dialog, used to edit the pad friction coefficient as a function of lining temperature.

Material ... Opens the Brake Designer Material Properties dialog, used to edit the rotor and pad material thermal properties.

Apply Recomputes the results below from the current physical parameters.

Brake Factor *(read-only)* Calculated ratio of total rotor drag force to actuation force for the brake.

Actuation Factor *(read-only)* Calculated actuation force per unit of system pressure.

Brake Torque Ratio (in-lb/psi) *(read-only)* Calculated wheel brake torque per unit of system pressure. On pressing OK, this value replaces the Brake Torque Ratio in the Brake Assembly dialog.

Removed options

The following entries from the previous manual are no longer present in this dialog:

- **Number of Rotors** — removed; the model uses a single rotor per wheel.
- **Middle Pad Thickness** — removed; pad thickness is now entered per inner/outer pad.
- **Preview** button — removed; the schematic preview drawing is now always displayed in the dialog.

Updated to match the current version of HVE.

Drive Train Dialog Box

The Drivetrain parameters for the current vehicle are displayed and edited using the Drivetrain dialog box. The drivetrain is composed of three components that are edited individually:

- Engine
- Transmission
- Differential

This dialog box contains the following items:

Chart

Graphical display of the current engine table (engine output vs engine speed). The chart is redrawn to reflect edits made in the data grid after pressing Apply.

Engine Name

User-editable description of the engine (drivetrain) for the current vehicle.

Throttle Position

Radio buttons selecting which engine table is displayed and edited in the data grid:

Wide Open Throttle Engine output table at full (wide open) throttle.

Closed Throttle Engine output table at closed throttle (engine braking).

Data Grid

A grid containing the engine table for the selected throttle position. Each row contains an Engine Speed (RPM) and the corresponding engine Power; the Torque column is calculated automatically from the speed and power entries. Rows are sorted by engine speed, and duplicate or incomplete rows are flagged when the data are applied.

Engine Idle Speed (RPM)

Idle speed of the engine.

(New option; not documented in the previous manual.)

Apply

Validates the data grid entries and redraws the chart using the current table.

Print...

Prints the engine chart.

Transmission...

Displays the Transmission Data Dialog Box.

Differential...

Displays the Differential Data Dialog Box.

TCS/YSC...

Displays the Electronic Stability System dialog, used to indicate whether Traction Control (TCS) and/or Yaw Stability Control (YSC) are installed, and to edit their activation thresholds (velocity, yaw velocity error, wheel spin velocity error, wheel side-to-side difference, axle-to-axle difference, drive torque and brake pressure) and activation rates (drive torque change and brake pressure change).

(New option; not documented in the previous manual.)

Drivetrain Inertia (lb-sec^2-in)

Rotational inertia of drivetrain components.

Updated to match the current version of HVE.

Dual Piston Brake Dialog Box

The brake factor for a dual piston drum brake (Dual Piston, 2 Leading Shoes) is calculated by assuming the primary and secondary shoes are each a pinned leading shoe. Like a single piston brake, some dual piston drum brakes use a different piston area for the primary and secondary shoes. Therefore, the actuation force is calculated separately for the primary and secondary shoes. The dialog includes a schematic preview drawing of the brake, updated to reflect the current dimensions.

This dialog box contains the following attributes:

Wheel Cylinder

Area, Primary Piston (in^2) Cross-sectional area of the wheel cylinder piston acting on the primary shoe.

Area, Secondary Piston (in^2) Cross-sectional area of the wheel cylinder piston acting on the secondary shoe.

Push-out Pressure (psi) Pressure required to overcome force associated with return springs and begin developing brake torque.

Shoe/Drum

Drum Diameter (in) Inside diameter of the brake drum.

Drum Lining Width (in) Width of lining material.

Drum Thickness (in) Thickness of the drum wall (used for calculating the thermal mass of the drum).

Lining (Primary and Secondary columns)

The following parameters are entered separately for the primary (Pri) and secondary (Sec) shoes.

Lining Arc Length (in) Length of the lining material along the arc of contact with the drum.

Lining Alph 1 (deg) (labeled *Lining Alph 1* in the dialog — a UI typo for *Lining Alpha 1*) Angle locating the leading edge of the lining relative to the shoe actuation axis.

Lining Thickness (in) Thickness of lining material.

Shoe Pin Radius (in) Radial distance from the center of the brake to the anchor pin for pinned brake shoes. (The secondary shoe value follows the primary and is not directly editable.)

Shoe Block Length (in) Length of the shoe abutment block. (The secondary shoe value follows the primary and is not directly editable.)

Mechanical Efficiency Fraction of the actuation force actually delivered to the shoes after mechanical losses.

Buttons and Results

Friction ... Opens the Lining Friction Properties dialog, used to edit the lining friction coefficient as a function of lining temperature for the primary and secondary linings.

Material ... Opens the Brake Designer Material Properties dialog, used to edit the drum and lining material thermal properties.

Apply Recomputes the results below from the current physical parameters.

Brake Factor *(read-only)* Calculated ratio of total drum drag force to actuation force for the brake.

Actuation Factor *(read-only)* Calculated actuation force per unit of system pressure.

Brake Torque Ratio (in-lb/psi) *(read-only)* Calculated wheel brake torque per unit of system pressure. On pressing OK, this value replaces the Brake Torque Ratio in the Brake Assembly dialog.

Removed options

- **Preview** button — removed; the schematic preview drawing is now always displayed in the dialog.

Updated to match the current version of HVE.

Dual Wedge Brake Dialog Box

This Brake Designer dialog is used to edit the physical parameters of an air-actuated dual wedge drum brake, in which two air chambers drive wedges that spread the shoes against the drum. The dialog includes a schematic preview drawing of the brake, updated to reflect the current dimensions.

Air Chamber

Chamber Drop-down list selecting the air chamber size, by standard chamber type (Type 9, 12, 18, 20, 24, 30 or 36). Selecting a chamber type automatically sets the Chamber Area to the corresponding nominal effective area.

Chamber Area (in^2) Effective diaphragm area of the air chamber. Set automatically from the selected chamber type; may also be edited directly. (The previous manual listed this as "Area, Primary Chamber".)

Push-out Pressure (psi) Pressure required to overcome force associated with return springs and begin developing brake torque.

Wedge

Wedge Location (in) Location of the wedge actuation point relative to the brake center.

Wedge Angle, Primary (deg) Included angle of the wedge actuating the primary shoe.

Wedge Angle, Secondary (deg) Included angle of the wedge actuating the secondary shoe.

Maximum Stroke (in) Maximum available stroke of the air chamber push rod.

Stroke @ 2ndary Defl (in) Push rod stroke at which secondary (structural) deflection begins.

2ndary Defl. Factor Factor describing the additional stroke consumed by secondary deflection after the secondary deflection stroke is reached.

Expansion Coef (in/deg F) Thermal expansion coefficient of the drum; used to compute the additional stroke required as the drum heats and expands.

Shoe/Drum

Drum Diameter (in) Inside diameter of the brake drum.

Drum Lining Width (in) Width of the lining material.

Drum Thickness (in) Thickness of the drum wall (used for calculating the thermal mass of the drum).

Lining (Primary and Secondary columns)

The following parameters are entered separately for the primary (Pri) and secondary (Sec) shoes.

Lining Arc Length (in) Length of the lining material along the arc of contact with the drum.

Lining Alph 1 (deg) (labeled *Lining Alph 1* in the dialog — a UI typo for *Lining Alpha 1*) Angle locating the leading edge of the lining relative to the shoe actuation axis.

Lining Thickness (in) Thickness of the lining material.

Abutment Dist (in) Distance from the brake center to the shoe abutment. (The secondary shoe value follows the primary and is read-only.)

Abutment Width (in) Width of the shoe abutment. (The secondary shoe value follows the primary and is read-only.)

Mechanical Efficiency Fraction of the actuation force actually delivered to the shoes after mechanical losses.

Buttons and Results

Friction ... Opens the Lining Friction Properties dialog, used to edit the lining friction coefficient as a function of lining temperature for the primary and secondary linings.

Material ... Opens the Brake Designer Material Properties dialog, used to edit the drum and lining material thermal properties.

Apply Recomputes the results below from the current physical parameters.

Brake Factor *(read-only)* Calculated ratio of total drum drag force to actuation force for the brake.

Actuation Factor *(read-only)* Calculated actuation force per unit of system pressure.

Brake Torque Ratio (in-lb/psi) *(read-only)* Calculated wheel brake torque per unit of system pressure. On pressing OK, this value replaces the Brake Torque Ratio in the Brake Assembly dialog.

Removed options

- **Preview** button — removed; the schematic preview drawing is now always displayed in the dialog.

Updated to match the current version of HVE.

Duo Servo Brake Dialog Box

This Brake Designer dialog is used to edit the physical parameters of a duo-servo drum brake, in which the primary shoe drives the secondary shoe through a link, producing a self-energizing (servo) action. The dialog includes a schematic preview drawing of the brake, updated to reflect the current dimensions. (The previous manual titled this topic "Due Servo Brake"; the correct name is Duo Servo.)

Wheel Cylinder

Piston Diameter (in) Diameter of the wheel cylinder piston.

Wheel Cyl. Dist (in) Distance from the brake center to the wheel cylinder actuation point.

Push-out Pressure (psi) Pressure required to overcome force associated with return springs and begin developing brake torque.

Shoe/Drum

Drum Diameter (in) Inside diameter of the brake drum.

Drum Lining Width (in) Width of the lining material.

Drum Thickness (in) Thickness of the drum wall (used for calculating the thermal mass of the drum).

Lining (Primary and Secondary columns)

The following parameters are entered separately for the primary (Pri) and secondary (Sec) shoes. Parameters that apply to only one shoe of a duo-servo brake are disabled for the other shoe.

Lining Arc Length (in) Length of the lining material along the arc of contact with the drum.

Lining Alph 1 (deg) (labeled *Lining Alph 1* in the dialog — a UI typo for *Lining Alpha 1*) Angle locating the leading edge of the lining relative to the shoe actuation axis. (Entered for the secondary shoe only.)

Lining Beta (deg) Angle locating the lining relative to the shoe abutment. (Entered for the primary shoe only.)

Lining Thickness (in) Thickness of the lining material.

Abutment Dist (in) Distance from the brake center to the primary shoe abutment (the link between the shoes). (Entered for the primary shoe only.)

Abutment Width/2 (in) Half-width of the shoe abutment. (Entered for the primary shoe only.)

Abutment Angle (deg) Angle of the abutment contact surface. (Entered for the primary shoe only.)

Abutment Friction Coefficient of friction at the abutment contact. (Entered for the primary shoe only.)

Shoe Pin Radius (in) Radial distance from the center of the brake to the anchor pin for the pinned (secondary) shoe. (Entered for the secondary shoe only.)

Shoe Block Length (in) Length of the shoe abutment block. (Entered for the secondary shoe only.)

Mechanical Efficiency Fraction of the actuation force actually delivered to the shoes after mechanical losses.

Buttons and Results

Friction ... Opens the Lining Friction Properties dialog, used to edit the lining friction coefficient as a function of lining temperature for the primary and secondary linings.

Material ... Opens the Brake Designer Material Properties dialog, used to edit the drum and lining material thermal properties.

Apply Recomputes the results below from the current physical parameters.

Brake Factor *(read-only)* Calculated ratio of total drum drag force to actuation force for the brake.

Actuation Factor *(read-only)* Calculated actuation force per unit of system pressure.

Brake Torque Ratio (in-lb/psi) *(read-only)* Calculated wheel brake torque per unit of system pressure. On pressing OK, this value replaces the Brake Torque Ratio in the Brake Assembly dialog.

Removed options

- **Preview** button — removed; the schematic preview drawing is now always displayed in the dialog.

Updated to match the current version of HVE.

Duplex Brake Dialog Box

This Brake Designer dialog is used to edit the physical parameters of a duplex drum brake, in which each shoe is actuated by its own wheel cylinder and both shoes act as leading shoes. The dialog includes a schematic preview drawing of the brake, updated to reflect the current dimensions.

Wheel Cylinder

Piston Diameter (in) Diameter of the wheel cylinder pistons.

Wheel Cyl. Dist (in) Distance from the brake center to the wheel cylinder actuation points.

Push-out Pressure (psi) Pressure required to overcome force associated with return springs and begin developing brake torque.

Shoe/Drum

Drum Diameter (in) Inside diameter of the brake drum.

Drum Lining Width (in) Width of the lining material.

Drum Thickness (in) Thickness of the drum wall (used for calculating the thermal mass of the drum).

Lining (Primary and Secondary columns)

The following parameters are entered separately for the primary (Pri) and secondary (Sec) shoes.

Lining Arc Length (deg) Arc length of the lining material in contact with the drum.

Lining Beta (deg) Angle locating the lining relative to the shoe abutment.

Lining Thickness (in) Thickness of the lining material.

Abutment Dist (in) Distance from the brake center to the shoe abutment. (The secondary shoe value follows the primary and is not directly editable.)

Abutment Width (in) Width of the shoe abutment. (The secondary shoe value follows the primary and is not directly editable.)

Abutment Angle (deg) Angle of the abutment contact surface. (The secondary shoe value follows the primary and is not directly editable.)

Abutment Friction Coefficient of friction at the abutment contact. (The secondary shoe value follows the primary and is not directly editable.)

Mechanical Efficiency Fraction of the actuation force actually delivered to the shoes after mechanical losses.

Buttons and Results

Friction ... Opens the Lining Friction Properties dialog, used to edit the lining friction coefficient as a function of lining temperature for the primary and secondary linings.

Material ... Opens the Brake Designer Material Properties dialog, used to edit the drum and lining material thermal properties.

Apply Recomputes the results below from the current physical parameters.

Brake Factor *(read-only)* Calculated ratio of total drum drag force to actuation force for the brake.

Actuation Factor *(read-only)* Calculated actuation force per unit of system pressure.

Brake Torque Ratio (in-lb/psi) *(read-only)* Calculated wheel brake torque per unit of system pressure. On pressing OK, this value replaces the Brake Torque Ratio in the Brake Assembly dialog.

Removed options

- **Preview** button — removed; the schematic preview drawing is now always displayed in the dialog.

Updated to match the current version of HVE.

Transmission Data Dialog Box

The HVE vehicle transmission is modeled by a reverse gear, neutral and up to 12 forward gears. The transmission is edited using the Transmission Data dialog, opened from the Drivetrain dialog.

This dialog box contains the following items:

Gears

Drop-down list specifying the number of forward gears (2 through 12 speeds).

Data Grid

A grid containing one row for Reverse plus one row for each forward gear, with the following columns:

- **Gear** — Name of each gear (Rev, 1, 2, ... up to 12). This column is read-only.
- **Ratio** — Gear ratio for each gear.

Type

Radio buttons selecting the transmission type: **Standard** (manual) or **Automatic**. Selecting Automatic enables the Shift Points group below. *(New option; not documented in the previous manual.)*

Shift Points

Parameters defining the automatic transmission shift schedule. These controls are enabled only when the transmission type is Automatic.

(New group; not documented in the previous manual.)

Engine Speed (RPM) Low and high engine speeds bounding the shift schedule.

Upshift Point (%WOT) Throttle positions (percent of wide open throttle) at the low and high engine speeds above which an upshift occurs.

Downshift Point (%WOT) Throttle positions (percent of wide open throttle) at the low and high engine speeds below which a downshift occurs.

Shift Graph

Graphical display of the shift schedule: throttle position vs engine speed, showing the upshift and downshift lines between the low- and high-speed shift points. The graph is redrawn after pressing Apply.

(New item; not documented in the previous manual.)

Apply

Validates the entered values and redraws the shift graph.

Updated to match the current version of HVE.

Tires & Wheels

Dialog and feature reference for the HVE **Tires & Wheels** area, converted from the on-line help and verified against the current release. Part of the HVE Manual.

Pages

- Fy vs Inclination Angle Dialog
- Slip vs Roll-Off Dialog
- Tire Friction Data Dialog
- Tire Information Dialog
- Tire Physical Data Dialog
- Tire Save As Dialog
- Wheels — Blow-out Page
- Wheels — Damage (Displacement) Page
- Wheels — Brake Page
- Wheel Properties Dialog

Fy vs Inclination Angle Dialog

The tire F_y vs inclination (camber) angle data for the selected wheel position are displayed and edited using this dialog (title: *Fy vs Inclination Angle: <Mfr> <Model> <Size>*).

Camber thrust data are stored as tables of up to 3 test loads by up to 3 test speeds; a separate camber angle vs lateral force table (up to 9 points) is maintained for each load/speed combination.

This dialog contains the following items:

Fy vs Inclination Angle Graph

A graph of lateral force F_y versus camber (inclination) angle, drawn from the current data table and camber stiffness. The graph is redrawn when Apply is pressed.

Load

Vertical tire load at which the camber stiffness values were obtained. The drop-down list contains the test loads in the table (up to 3).

Speed

Road speed at which the camber stiffness values were obtained. The drop-down list contains the test speeds in the table (up to 3).

Data Grid

Editable table of *Camber Angle (deg)* vs *F_y (lb)* points for the selected load and speed (up to 9 rows). Rows are automatically sorted; incomplete rows and duplicate camber angle entries are rejected when the dialog is accepted or applied.

Camber Stiffness

Slope of the F_y vs Camber Angle curve at the graph's origin.

In-Use Factor

Global multiplier for the dependent values (F_y and camber stiffness). Applies to the entire camber table.

Add...

Adds a new test Load or Speed value to the table (limited to 3 loads and 3 speeds). Data for the new entry are seeded from the neighboring table entries and may then be edited. (New since the original help.)

Delete...

Removes the selected test Load or Speed (and its associated data table) from the table. (New since the original help.)

Edit...

Changes the numeric value of an existing test Load or Speed; the table is re-sorted afterwards. (New since the original help.)

Print...

Prints the displayed graph.

Apply

Redraws the graph using the given data.

OK / Cancel

OK validates the grid and parameter entries against their allowed ranges and stores the camber data for the tire. Cancel discards all changes.

Updated to match the current version of HVE.

Slip vs Roll-Off Dialog

The tire longitudinal and lateral slip vs roll-off data tables for the selected wheel position are displayed and edited using this dialog (title:

Roll-Off Data: <Mfr> <Model> <Size>

).

Roll-off data are stored as a table of up to 6 longitudinal slip values by up to 6 slip angle values; a longitudinal and a lateral roll-off factor are entered for each combination.

This dialog contains the following items:

Slip vs Roll-Off Graph

A graph showing the relationship between slip and roll-off, drawn from the current table. The graph is redrawn when Apply is pressed.

Longitudinal Slip

Longitudinal tire slip at which the lateral roll-off values were obtained. The drop-down list contains the longitudinal slip breakpoints in the table (up to 6).

Slip Angle

Lateral tire slip (slip angle) at which the longitudinal roll-off values were obtained. The drop-down list contains the slip angle breakpoints in the table (up to 6).

Longitudinal Roll-Off

Reduction in lateral tire force (relative to the tire axis system) at the specified longitudinal slip.

Lateral Roll-Off

Reduction in longitudinal tire force (relative to the tire axis system) at the specified lateral slip (slip angle).

Add...

Adds a new Longitudinal Slip or Slip Angle breakpoint to the roll-off table (limited to 6 of each). Roll-off values for the new entry are seeded from the neighboring table entries and may then be edited. (New since the original help.)

Delete...

Removes the selected Longitudinal Slip or Slip Angle breakpoint (and its associated roll-off data) from the table. (New since the original help.)

Edit...

Changes the numeric value of an existing Longitudinal Slip or Slip Angle breakpoint; the table is re-sorted afterwards. (New since the original help.)

Print...

Prints the currently displayed graph.

Apply

Redraws the graph with the new values.

OK / Cancel

OK validates the entries against their allowed ranges and stores the roll-off table for the tire. Cancel discards all changes.

Updated to match the current version of HVE.

Tire Friction Data Dialog

The tire frictional properties for the selected wheel position are displayed and edited using this dialog (title: *Friction Table: <Mfr> <Model> <Size>*).

Friction data are stored as a table of up to 3 test loads by up to 3 test speeds; the parameters below are entered for each load/speed combination. The physics models interpolate between table entries at run time.

This dialog contains the following items:

Tire Friction Graph

A graph of *Friction vs. Slip* (friction, F_x/F_z, versus longitudinal slip) drawn from the current parameters, showing both the longitudinal and lateral curves. The graph is redrawn when Apply is pressed.

Load

Vertical tire load at which the frictional values were obtained. The drop-down list contains the test loads in the friction table (up to 3); selecting a load displays the friction parameters for that load at the current speed.

Speed

Road speed at which the frictional values were obtained. The drop-down list contains the test speeds in the friction table (up to 3); selecting a speed displays the friction parameters for the current load at that speed.

Peak Longitudinal Friction

Maximum value of F_x/F_z achieved during the test at the given load and speed.

Peak Lateral Friction

Maximum value of F_y/F_z achieved during the test at the given load and speed.

Slide Friction

Value of F_x/F_z at 100 percent longitudinal slip achieved during the test at the given load and speed.

Slip at Peak Long. Friction

Longitudinal slip at which the peak longitudinal friction was achieved at the given load and speed.

Longitudinal Stiffness

Slope of the Friction vs. Slip curve at the graph's origin (lb/slip).

In-Use Factor

Global multiplier for the dependent values (peak and slide friction, longitudinal stiffness). Applies to the entire friction table.

Add...

Adds a new test Load or Speed value to the friction table. A prompt asks whether the new value is a Load or a Speed; the table is limited to 3 loads and 3 speeds. Data for the new entry are seeded from the neighboring table column/row and may then be edited. (New since the original help.)

Delete...

Removes the selected test Load or Speed (and its associated friction data) from the table. (New since the original help.)

Edit...

Changes the numeric value of an existing test Load or Speed; the table is re-sorted afterwards. (New since the original help.)

Print...

Prints the currently displayed graph.

Apply

Redraws the graph with the given data.

OK / Cancel

OK validates the entries against their allowed ranges and stores the friction table for the tire. Cancel discards all changes.

Updated to match the current version of HVE.

Tire Information Dialog

The tire parameters for the current vehicle are displayed and edited using the Tire Information dialog. The dialog title bar shows the name of the current vehicle and the wheel position being edited, e.g.

Tire Information: <Vehicle Name> (Axle 1, Left Side)

.

This dialog contains the following items:

Name

Name of the currently selected tire. The name is editable; while it retains its default form, it is automatically rebuilt from the Type, Manufacturer, Model, Size and Source Database selections. The name must be unique within the case.

Type

Tire type. The available types are Passenger Car, Light Truck, Heavy Truck and Mobile Home (only types present in the loaded tire databases are listed). Changing the type refreshes the Manufacturer, Model, Size and Source Database lists.

Manufacturer

Manufacturer of the selected tire. The list contains all manufacturers available in the tire databases for the chosen Type.

Model

Model of the selected tire, as available in the tire databases for the chosen Type and Manufacturer. (The dialog label reads "Modal" in some versions; it refers to the tire model.)

Size

Size designation of the selected tire (e.g. P215/65R15). The size string is parsed to compute the tire's section width, rim radius and outside radius; an invalid or incompatible size string produces an error when the dialog is accepted.

Source Database

Database file from which the selected tire's data are drawn (e.g. EDVDB.DB, User.DB). When more than one database contains the same tire, each source is listed. Use of the EDC custom vehicle database (Edc.db) requires the appropriate license.

Mass

Mass of the selected tire, as stored in the selected source database. This field is display-only; it updates as the Type/Manufacturer/Model/Size/Source Database selections change. (New since the original help.)

Dual Tires

Check box indicating that this wheel position uses dual tires. Checking it enables the Dual Tire Spacing field.

Dual Tire Spacing

Lateral distance between the centerlines of the two tires of a dual pair. Enabled only when Dual Tires is checked.

Physical Data...

Displays the Tire Physical Data dialog.

Friction...

Displays the Tire Friction Data dialog.

Fy vs Slip Angle...

Displays the Tire F_y vs Slip Angle dialog (see FyVsSlipAngDlg).

Fy vs Inclination Angle...

Displays the F_y vs Inclination Angle dialog.

Slip vs Roll-Off...

Displays the Slip vs Roll-Off dialog.

Copy to Other Side

Copies all the settings of the selected tire (including dual tire settings) to the tire on the other side of the same axle when the dialog is accepted.

Copy to Other Axles

Copies the selected tire to the same side of all other axles of the vehicle when the dialog is accepted. If Copy to Other Side is also checked, the tire is copied to every wheel position on the vehicle. (New since the original help.)

Save As...

Displays the Tire Save As dialog, which saves the current tire to the user database on disk.

Delete

Removes the tire from the user database (User.DB) after confirmation, then rebuilds the vehicle database. This button is enabled only for tires that reside in the user database.

OK / Cancel

OK validates the entries (dual tire spacing range, unique tire name, valid tire size string), stores the tire at the selected wheel position and applies any Copy to Other Side / Copy to Other Axles requests. Cancel discards all changes.

Updated to match the current version of HVE.

Tire Physical Data Dialog

The tire physical parameters for the selected wheel position are displayed and edited using the Tire Physical Data dialog (title:

Tire Physical Data: <Mfr> <Model> <Size>

). Each parameter may be set with a slider or typed directly into its edit field.

This dialog contains the following items (in dialog order):

Unloaded Radius

Undeflected tire radius (no-load condition).

Maximum Width

Maximum section width of the tire. This value is display-only; it is computed from the tire size designation string. (New since the original help.)

Tread Width

Width of the tire tread contact patch. (New since the original help.)

Tread Depth

Depth of the tire tread. (New since the original help.)

Nominal Pressure

Nominal (rated) inflation pressure of the tire. (New since the original help.)

Initial Deflection Rate

The initial tire spring rate (vertical tire load per unit of linear tire deflection).

Secondary Deflection Rate

The spring rate under conditions of excessive tire vertical load.

Deflection at Secondary Rate

Tire deflection at which the secondary deflection rate begins.

Maximum Deflection

Tire maximum deflection. This value is normally used to terminate execution, indicating the probability of a damaged or broken wheel rim.

Pneumatic Trail

Longitudinal distance from the center of the tire contact patch to the center of pressure. Pneumatic trail increases the self-aligning tendency of a steerable wheel.

Aligning Torque Coef

Self-aligning torque coefficient due to mechanical and pneumatic trail.

Weight

Total weight of the wheel assembly (tire plus rim). For an independent suspension, the value reflects the total unsprung mass. For a solid axle suspension system, the axle weight is added to the wheel weight to determine unsprung mass. The displayed weight is calculated from the stored tire mass.

Spin Inertia

Tire rotational inertia about its spin axis.

Steer Inertia

Tire rotational inertia about its steering axis.

Rolling Resist Const

Tire rolling resistance constant force coefficient.

Rolling Resist Linear

Tire rolling resistance linear, velocity-dependent force coefficient.

Min Fz For Skidmark

Minimum vertical tire force required in order to cause a visible tire mark on the road.

OK / Cancel

OK validates each entry against its allowed range and stores the physical data for the tire. Cancel discards all changes.

Updated to match the current version of HVE.

Tire Save As Dialog

The Tire Save As dialog saves the current tire, including all of its physical, friction, cornering, camber and roll-off data, to the user database (User.DB). The saved tire then becomes available for selection from the Tire Information dialog with User.DB as its Source Database.

This dialog contains the following items:

Type

Tire type of the tire being saved (PassengerCar, LightTruck, HeavyTruck or MobileHome). This field is read-only; the type is inherited from the tire selected in the Tire Information dialog.

Manufacturer

Manufacturer name under which the tire will be stored.

Model

Model name under which the tire will be stored.

Size

Tire size designation string. The string is parsed when OK is pressed; the resulting tire width and radius must fall within valid ranges, otherwise an error is displayed and the tire is not saved. The parsed width also updates the tire's Maximum Width physical parameter.

Security Key

Optional security key stored with the tire record.

Version Information

Version string stored with the tire record (initialized from the source tire's version number).

OK / Cancel / Help

OK writes the tire to the user database. The combination of Type, Manufacturer, Model and Size forms the database key; if a tire with the same key already exists, you are asked whether to overwrite it. After saving, the vehicle database is rebuilt so the new tire is immediately available. Cancel closes the dialog without saving. Help displays this topic.

Updated to match the current version of HVE.

Wheels — Blow-out Page

The Event Wheels option displays a tabbed property sheet. The tabs shown depend on the options supported by the active physics (calculation) model:

- **Blow-out** — the tire blow-out model (this topic)
- **Damage** — wheel displacement/damage (see Wheels — Damage Page)
- **Brake** — per-wheel brake adjustment and failure (see Wheels — Brake Page)
- **Tire-Terrain** — per-wheel tire-terrain friction options (new since the original help)

Blow-out

The HVE Tire Blow-out Model is set up using the Blow-out page. The tire blow-out model allows the user to vary tire performance parameters (cornering, camber and radial stiffness and rolling resistance) while the simulation is running.

The page contains the following items:

Axle No

Axle index. Only the axles that exist on the current vehicle (1, 2 or 3) are listed.

Side

Side index (Left or Right).

Location

Tire location index (Inner or Outer). Enabled only when the selected wheel position uses dual tires.

Tire is Blown

Check box indicating whether the tire at the selected position blows out during the event. The remaining blow-out parameters are enabled only when this box is checked.

Auto Start

Check box indicating that the blow-out start time is set automatically by the simulation. When checked, the Start Time field is disabled.

Start Time

Simulation time at which the blow-out starts (sec). Disabled when Auto Start is checked.

Duration

Duration over which the air loss occurs (sec).

Stiffness Factor

Multiplier applied to the tire stiffness parameters (cornering, camber and radial stiffness) of the blown tire.

Rolling Resistance Factor

Multiplier for the tire rolling resistance of the blown tire. This field is enabled only when the event's driver controls use pedal-force braking (the rolling resistance effect requires that brake option).

Updated to match the current version of HVE.

Wheels — Damage (Displacement) Page

The wheel Damage page (formerly

Displacement

) of the Event Wheels property sheet is used to dynamically vary wheel position and orientation during the simulation, and — for physics models that support wheel damage — to model wheel lock-up and DyMESH-based wheel damage forces.

The page contains the following items:

Axle No

Axle index. Only the axles that exist on the current vehicle (1, 2 or 3) are listed.

Side

Side index (Left or Right).

Displacement (Change in Coordinates)

x — Vehicle-fixed wheel displacement distance in the X coordinate.

y — Vehicle-fixed wheel displacement distance in the Y coordinate.

z — Vehicle-fixed wheel displacement distance in the Z coordinate.

Change in Camber

Vehicle-fixed wheel camber change angle (deg).

Wheel is Damaged

Check box indicating that the wheel at the selected position is displaced/damaged during the event. The remaining fields on the page are enabled only when this box is checked. (The original help listed this as "Wheel is displayed", a typographical error.)

Auto Start

Check box indicating that the start time is set automatically by the simulation (e.g. at impact). When checked, the Start Time field is disabled.

Start Time

Simulation time at which the wheel displacement starts (sec). Disabled when Auto Start is checked.

Duration

Duration over which the wheel displacement occurs (sec).

Peak Lock-up Torque

Peak wheel lock-up torque applied to the damaged wheel, as a fraction (%/100). Enabled only when the active physics model supports the wheel damage option. (New since the original help.)

Use DyMESH

Check box enabling DyMESH-computed wheel damage for this wheel. Available only when the event uses DyMESH. Checking it enables the wheel damage force/moment parameters below. (New since the original help.)

Use Environment

Check box enabling wheel contact with the environment mesh when DyMESH wheel damage is in use. Available only when the DyMESH "Use Environment" option is active for the event. (New since the original help.)

Max No-Damage Force

Maximum contact force (lb) the wheel can sustain without being displaced/damaged. (New since the original help.)

Displacement Rate

Rate at which wheel displacement grows with contact force above the no-damage threshold (lb/in). (New since the original help.)

Max Force

Maximum contact force (lb) used by the wheel damage model. (New since the original help.)

Max No-Damage Moment

Maximum contact moment (in-lb) the wheel can sustain without angular displacement/damage. (New since the original help.)

Moment Displacement Rate

Rate at which wheel angular displacement grows with contact moment above the no-damage threshold (in-lb/rad). (New since the original help.)

Max Moment

Maximum contact moment (in-lb) used by the wheel damage model. (New since the original help.)

Updated to match the current version of HVE.

Wheels — Brake Page

The wheel Brake page of the Event Wheels property sheet allows the user to simulate the effects of brake adjustment on brake systems by specifying initial stroke (adjuster slack) and pad/lining and rotor/drum temperatures at each wheel, and — for physics models that support it — to simulate per-wheel brake failure during the event.

The page contains the following items:

Axle No

Axle index. Only the axles that exist on the current vehicle (1, 2 or 3) are listed.

Side

Side index (Left or Right).

Brake Designer

Initial Pad/Lining Temp — Temperature of the brake pad/lining at the start of the simulation.

Initial Rotor/Drum Temp — Temperature of the brake rotor/drum at the start of the simulation.

Initial Stroke (Adjuster Slack) — Initial actuator stroke (in) at the start of the simulation, reflecting the state of brake adjustment.

These fields are enabled according to the brake temperature and brake adjustment options supported by the active physics model.

Brake Failure

This group is new since the original help. It is enabled only when the active physics model supports the wheel brake failure option.

Brake Is Failed — Check box indicating that the brake at the selected wheel position fails during the event. The failure parameters below are enabled only when this box is checked.

Auto Start — Check box indicating that the failure start time is set automatically by the simulation. When checked, the Start Time field is disabled.

Start Time — Simulation time at which the brake failure starts (sec).

Duration — Duration over which the brake failure develops (sec).

Amount of Failure (Failure Extent) — Fraction of braking capacity lost at the wheel (%/100); 1.0 represents complete loss of braking at that wheel.

Updated to match the current version of HVE.

Wheel Properties Dialog

Clicking on a wheel of the current vehicle displays the Wheel popup dialog, from which you can navigate to the following options for the selected wheel position:

Suspension...

Displays the Suspension Data dialog (see SuspDlg).

Brake...

Displays the Brake Assembly dialog (see BrkAsmblyDlg).

Tire...

Displays the Tire Information dialog.

Wheel Location...

Displays the Wheel Location dialog (see WheelLocDlg).

Wheel Image...

Displays a submenu for assigning a wheel (rim) image. Choose New or Open, applied to This Wheel, This Axle or All Wheels. (New since the original help.)

Tire Sidewall Image...

Displays a submenu for assigning a tire sidewall image. Choose New or Open, applied to This Tire, This Axle or All Tires. (New since the original help.)

Tire Tread Image...

Displays a submenu for assigning a tire tread image. Choose New or Open, applied to This Tire, This Axle or All Tires. (New since the original help.)

Track Color...

Displays a submenu for setting the color used to draw this tire's track (tire path) marks: This Wheel, This Axle or All Wheels. (New since the original help.)

Skid Color...

Displays a submenu for setting the color used to draw this tire's skid marks: This Wheel, This Axle or All Wheels. (New since the original help.)

Cancel

Closes the popup without making a selection.

Updated to match the current version of HVE.

Safety Systems

Dialog and feature reference for the HVE **Safety Systems** area, converted from the on-line help and verified against the current release. Part of the HVE Manual.

Pages

- Accelerometers Dialog
- Air Bag Restraints Dialog Box
- Airbag Restraint System Dialog Box
- Belt Restraint System Dialog Box

Accelerometers Dialog

The Accelerometers dialog (title:

Accelerometer Data: [vehicle name]

) allows the user to assign the vehicle-fixed x, y, z coordinates for up to five accelerometers. The simulation model can then return the velocity and acceleration at each selected location. Accelerometers are assigned in event mode using this dialog.

Coordinates are entered in the vehicle-fixed coordinate system. If the vehicle dimensions basis is set to Total (rather than Sprung) in the Options, the displayed coordinates are adjusted accordingly.

Location No.

A drop-down list used to select the accelerometer device being edited (1 through 5). All remaining fields apply to the currently selected device.

Device In Use

A checkbox indicating whether the selected accelerometer is in use. Default: not in use. When unchecked, the coordinate fields below are disabled.

Coordinates (in) - x

Vehicle-fixed x coordinate of the accelerometer. Default: 0. Typical range ±300 in; allowed range ±500 in.

y

Vehicle-fixed y coordinate of the accelerometer. Default: 0. Typical range ±102 in; allowed range ±500 in.

z

Vehicle-fixed z coordinate of the accelerometer. Default: 0. Typical range ±300 in; allowed range ±500 in. This field is read-only if the event's calculation method does not compute 3-dimensional position and velocity (per the physics program's options).

Updated to match the current version of HVE.

Air Bag Restraints Dialog Box

The airbag restraint systems of the vehicle are displayed and edited using the Air Bag dialog (title:

Air Bag: [vehicle name]

). Program units for vehicle airbag restraint properties are displayed with each field label. Values entered outside the typical range produce a warning; values outside the allowed range are rejected.

Note: Deploy coordinates are entered in the vehicle-fixed coordinate system. If the vehicle dimensions basis is set to Total (rather than Sprung) in the Options, the displayed coordinates are adjusted accordingly.

Seat Position

A drop-down list used to select the occupant location of the airbag being edited. Nine positions are available: Front, Rear and Back rows, each with Right, Center and Left positions (e.g. "Front, Right"). All remaining fields in the dialog apply to the currently selected seat position.

Device Installed

A checkbox indicating that the vehicle has an airbag installed at the current seat position. Default: not installed. (An airbag must be installed here before it can be placed in use in the event's Airbag Restraint System dialog.)

Deploy Coords (in) - x, y, z

Assign the vehicle-fixed x, y and z coordinates where the airbag is installed and deployed. Defaults: x = 100, y = -40, z = -50 in. Typical range: x ±300 in, y and z ±60 in; allowed range ±500 in for each coordinate.

Initial Bag Radius (in)

Assigns the initial (undeployed) radius of the airbag. Default: 0.05 in. Typical range 2.0-15.0 in; allowed range 0.1-30.0 in.

Passenger Bag Length (in)

Assigns the length for non-driver-side (passenger) airbags. Default: 25 in. Typical range 10.0-48.0 in; allowed range 1.0-100.0 in.

Initial Pressure (lb/in^2)

Assigns the initial pressure inside the airbag. Default: 10 lb/in². Typical range 0.0-15.0; allowed range 0.0-50.0.

Bag Membrane Thickness (in)

Assigns the thickness of the airbag membrane (fabric) material. Default: 0.05 in. Typical range 0.001-0.05 in; allowed range 0.00001-0.1 in.

Full Inflation Volume (in^3)

Assigns the volume inside the airbag when fully inflated. Default: 12000 in^3. Typical range 10.0-5000.0 in^3; allowed range 1.0-50000.0 in^3.

Discharge Coefficient

Assigns the thermodynamic discharge coefficient for the airbag vent hole (dimensionless). Default: 0.5. Typical range 0.25-1.0; allowed range 0.10-1.0.

Discharge Vent Area (in^2)

Assigns the area of the airbag vent hole. Default: 10 in^2. Typical range 1.0-10.0 in^2; allowed range 0.01-20.0 in^2.

Pressure to Open Vent Hole (lb/in^2)

Assigns the airbag pressure required to cause the vent hole to open. Default: 0.5 lb/in^2. Typical range 0.0-10.0; allowed range 0.0-100.0.

Maximum Penetration (in)

Assigns the penetration (deflection distance) required before any force is computed. Default: 25 in. Typical range 0.001-10.0 in; allowed range 0.0-100.0 in.

Force Convergence Criterion (lb)

Assigns the permissible force imbalance between the airbag and contact surfaces. Default: 20 lb. Typical range 1.0-50.0 lb; allowed range 0.0001-200.0 lb.

Backside Contact Surface

An option list containing all the vehicle interior contact surfaces. The selected surface is used to assign the material properties for the contact surface supporting the airbag. This option is disabled (grayed out) if the vehicle has no contact surfaces defined.

Bag Elastic Modulus (lb/in^2)

Assigns the elastic modulus for the airbag material during airbag filling. Typical range 5000-20000 lb/in^2; allowed range 1000-50000 lb/in^2.

Bag Rebound Modulus (lb/in^2)

Assigns the elastic modulus for the airbag material during rebound. Typical range 10000-100000 lb/in^2; allowed range 5000-500000 lb/in^2.

Bag Bottom-out Modulus (lb/in^2)

Assigns the elastic modulus for the airbag material after it has bottomed out. Typical range 10-100 lb/in²; allowed range 1-5000 lb/in².

Gas Density (lb/in^3)

Assigns the gas density for the airbag filling agent. Typical range 0.000005-0.001 lb/in³; allowed range 0.0-1.0 lb/in³.

Gas Mass Flowrate (lb/sec)

Assigns the mass flow rate for the airbag filling gas. Typical range 1.0-100.0 lb/sec; allowed range 0.1-1000.0 lb/sec.

Gas Specific Heat Ratio

Assigns the specific heat ratio for the airbag filling agent (dimensionless). Typical range 0.9-1.1; allowed range 0.05-20.0.

Max. Column Collapse Dist (in)

Assigns the maximum distance the steering column is allowed to collapse (applies to driver-side airbags only). Typical range 1.0-20.0 in; allowed range 0.1-50.0 in.

Column Collapse Load (lb)

Assigns the axial load on the steering column required to begin collapsing the column (applies to driver-side airbags only). Typical range 100-5000 lb; allowed range 1-50000 lb.

Column Angle (deg)

Assigns the steering column angle, about the vehicle's pitch axis (normally a negative angle). Typical range ±45°; allowed range ±90°.

Updated to match the current version of HVE.

Airbag Restraint System Dialog Box

The Airbag Restraint System dialog is used in event mode to place an installed airbag in use for a specific occupant and to control when it deploys. The airbag itself (deploy location, bag geometry, gas properties, etc.) must first be installed on the vehicle using the vehicle editor's Air Bag dialog; a location's controls are enabled only if an airbag is installed there.

Airbag Restraints For

A drop-down list used to select the occupant (and seat location) receiving the airbag. Each occupied position is listed by the human's name followed by an abbreviated seat position label — (F/R), (F/C), (F/L), (B/R), (B/C), (B/L), (R/R), (R/C), (R/L) — for the nine possible occupant locations (Front/Back/Rear rows, Right/Center/Left positions). Unoccupied positions are not listed. A position can only be selected if the human at that position has an Initial Position human kit placed in the event; otherwise an error message is displayed and the previous selection is restored.

Device In Use

A checkbox that determines whether the airbag restraint installed at the selected location is in use for this event. Default: not in use. This checkbox is enabled only if an airbag is installed at the selected location on the vehicle. When unchecked, the remaining controls in the dialog are disabled.

Airbag Contacts

A multiple-selection list containing the contact ellipsoids of the human at the selected location (all ellipsoids of all body segments). Select the ellipsoid(s) that may contact the airbag; only the selected ellipsoids will develop contact forces with the airbag. (Note: earlier versions of this help described this field as the vehicle contact surface supporting the airbag; that surface is now assigned as the Backside Contact Surface in the vehicle editor's Air Bag dialog.)

AutoStart

A checkbox that determines how airbag deployment is triggered. When checked, deployment is started automatically by the simulation and the two fill-time fields below are disabled. When unchecked, the user specifies the deployment timing using Airbag Begin Fill Time and Airbag Fill Duration.

Airbag Begin Fill Time (sec)

The simulation time at which the airbag begins to fill. Default: 0.0010 sec. Allowed range 0.0010-40.0 sec. Only editable when AutoStart is unchecked.

Airbag Fill Duration (sec)

The length of time over which the airbag fills. Default: 0.05 sec. Typical range 0.0001-0.20 sec; allowed range 0-40 sec. Only editable when AutoStart is unchecked.

Updated to match the current version of HVE.

Belt Restraint System Dialog Box

The Belt Restraint System dialog (title:

Belt Restraint System Data: [vehicle name]

) is used in event mode to assign belt restraints to occupants. The belt hardware (torso and lap belt sections, anchor locations, webbing properties) must first be installed on the vehicle using the vehicle editor's Belt Restraints dialog; a belt segment can only be placed in use here if it is installed at the selected location. All controls are disabled unless at least one human in the event has an Initial Position human kit.

Each belt section is modeled as two belt segments (left and right). One end of each segment is attached to the human body segment selected below; the other end is attached to the anchor point on the vehicle.

Belt Restraints For

A drop-down list used to select the occupant (and seat location) receiving the belt restraint. Each occupied position is listed by the human's name followed by an abbreviated seat position label — (F/R), (F/C), (F/L), (B/R), (B/C), (B/L), (R/R), (R/C), (R/L) — for the nine possible occupant locations. Unoccupied positions are not listed. A position can only be selected if the human at that position has an Initial Position human kit placed in the event; otherwise an error message is displayed and the previous selection is restored.

(Note: earlier versions of this help listed "Torso Belt Restraint, Lap Belt Restraint, Airbag Restraint" as the choices for this list. That is no longer correct — the belt type is now chosen with the Belt Segment list below, and airbags are assigned using the separate Airbag Restraint System dialog.)

Belt Segment

A drop-down list used to select which belt section is being edited. The choices are:

- Torso Belt
- Lap Belt

Device In Use

A checkbox indicating whether the selected belt segment is in use for this event. Default: not in use. The checkbox is enabled only if the corresponding belt section (torso or lap) is installed at the selected location on the vehicle. When unchecked, the attachment and slack fields are disabled.

Belt Attached To

A drop-down list used to select the human body segment to which the ends of the belt segments are attached (the other ends attach to the anchor points on the vehicle). The choices are the five torso segments:

- Pelvis
- Abdomen
- Chest
- Neck

- Head

Segment Coordinates (in) - i, j, k (Left and Right columns)

Enter the i, j and k coordinates of the belt attachment point on the selected body segment, for the left and right belt endpoints, in the human segment's coordinate system. Defaults: 0, 0, 0. Typical range ±20 in for each coordinate; allowed range ±100 in.

Belt Slack (in) (Left and Right columns)

The amount of displacement between the ends of the belt allowed before creating belt tension, entered separately for the left and right belt segments (a negative value implies pre-load). Default: 0 in. Typical range -2.0 to 10.0 in; allowed range -4.0 to 100.0 in.

Updated to match the current version of HVE.

Humans

Dialog and feature reference for the HVE **Humans** area, converted from the on-line help and verified against the current release. Part of the HVE Manual.

Pages

- Inertial Data Dialog Box
- Human Contact Ellipsoids Dialog Box
- Injury Tolerance Data Dialog Box
- Joint Data Dialog Box
- Human Information Dialog
- Human CG Dialog Box
- Human Joint Properties Dialog Box
- Human Material Properties Dialog Box
- Selected Humans & Vehicles Dialog Box

Inertial Data Dialog Box

Inertial parameters for the HVE Human Model are defined for each of the 15 segments. To view and edit the current human's inertial parameters, click on the desired segment CG and choose Inertias from the segment popup menu. The individual parameters are displayed in the Inertial Data dialog. The dialog title bar shows the current human's name and the selected segment (e.g. Pelvis, Chest, Head).

Weight

Weight of the selected segment. This field is editable; as the weight is changed, HVE recalculates the segment mass by dividing the entered weight by the current acceleration of gravity (taken from the current environment) and updates the Mass field immediately.

Mass

Segment mass, calculated as Weight divided by the current acceleration of gravity. This field is read-only.

Inertia

Roll Rotational inertia about the segment i axis.

Pitch Rotational inertia about the segment j axis.

Yaw Rotational inertia about the segment k axis.

Total Weight

Total weight of the entire human, calculated as the sum of the masses of all 15 segments multiplied by the current acceleration of gravity. This field is read-only.

> Note: The old help described this field as the "Total weight of the selected segment"; it is actually the total weight of the whole human.

Entered values are range-checked when OK is pressed; out-of-range values must be corrected before the dialog will close.

Updated to match the current version of HVE.

Human Contact Ellipsoids Dialog Box

Ellipsoid properties for the HVE Human Model are defined for each of the 15 segments. Each segment may have up to 3 contact ellipsoids. To view and edit the current human's ellipsoid parameters, click on the desired segment CG and choose Ellipsoids from the segment popup menu. The individual parameters are displayed in the Contact Ellipsoids dialog. The dialog title bar shows the current human's name and the selected segment.

Current Ellipsoid

Drop-down list of the user-supplied names for each contact ellipsoid on the selected segment. Select an ellipsoid to display and edit its parameters.

Coordinates i, j, k

The i, j and k coordinates of the center of the selected ellipsoid, defined relative to the segment principal axis system.

Semi-axis Length i, j, k

The i, j and k semi-axis lengths of the selected ellipsoid.

Principal Axes Roll, Pitch, Yaw

The roll, pitch and yaw angles of the ellipsoid axis system relative to the segment axis system.

Material Name

Read-only display of the human material currently assigned to the selected ellipsoid. If no material has been assigned, "Default Human Material" is displayed. Use the Material button to change the assigned material.

Add

Displays the New Ellipsoid dialog, which prompts for a name for the new ellipsoid. A segment may have at most 3 contact ellipsoids, and duplicate ellipsoid names on the same segment are not allowed; an error message is displayed in either case.

Delete

Removes the current contact ellipsoid from the selected segment after a confirmation prompt. The button is disabled when no ellipsoids remain.

Material

Displays the Human Material Properties Dialog Box, used to view, edit, open and save the human material assigned to the selected ellipsoid.

> Note: The old help linked the Material button to the (vehicle/environment) Material Properties dialog; the button actually opens the Human Material Properties dialog.

Updated to match the current version of HVE.

Injury Tolerance Data Dialog Box

Injury tolerances may be defined for the current human. These injury tolerances are used during the current event as guidelines to estimate when specific injuries might occur. Open the dialog by clicking on a segment CG and choosing Injury Tolerance from the segment popup menu. The dialog title bar shows the current human's name and the selected segment.

This dialog box contains the following parameters:

HIC

Head Injury Criterion, an empirically derived index used to estimate the probability of a closed head injury.

Head Pitch Concussion (deg/sec^2)

Tolerance for angular acceleration of the head about the pitch axis of the neck.

Head Side Acceleration (g)

Tolerance for linear acceleration of the head in the direction of the head-fixed side axis.

Chest SI (g)

Chest Severity Index, an injury index indicating the maximum chest acceleration.

Chest Force (lb)

The tolerance for peak force against the chest in the direction of the chest-fixed i-axis.

Chest Forward Accel (g)

The tolerance for peak chest acceleration in the direction of the chest-fixed i-axis.

> Note: This field appeared in the old help as "Chest Forward Access" (a typographical error).

Max Knee Force (lb)

The tolerance for peak force against the knee in the direction of the knee-fixed i-axis (peak axial femur loading).

Belt Injury Tolerance

The belt tolerances are entered separately for the Left Belt and Right Belt in the Belt Injury Tolerance group:

Max Lap Belt Force (lb) — Left Belt / Right Belt The tolerance for lap belt tension, above which injury is expected to occur. Separate values are entered for the left and right lap belt webbing.

Max Torso Belt Force (lb) — Left Belt / Right Belt The tolerance for torso belt tension, above which injury is expected to occur to the torso. Separate values are entered for the left and right torso belt webbing.

> Note: The old help listed a single Max Lap Belt Force and a single Max Torso Belt Force; the current dialog provides separate left- and right-belt entries (stored as LeftLap, RightLap, LeftTorso and RightTorso in the human data structure). The old description of Max Lap Belt Force as "peak axial loading of the femur" was incorrect — femur axial loading is covered by Max Knee Force.

Updated to match the current version of HVE.

Joint Data Dialog Box

Joint parameters for the HVE Human Model are defined for each of the 14 joints. Open the dialog by clicking on a segment CG and choosing Joints from the segment popup menu. The dialog contains an option list containing the names of each joint attached to the selected segment (a segment may have up to 4 attached joints), and the joint i, j, k coordinates relative to the selected segment coordinate system. The dialog title bar shows the current human's name and the selected segment.

Joint

Drop-down list of the joints attached to the selected segment. Select a joint to display and edit its properties.

Coordinates i, j, k

The i, j and k coordinates of the selected joint, defined relative to the segment principal axis system. Edited coordinates are range-checked when OK is pressed, and the human's 3-D geometry in the editor is updated to reflect the new joint positions.

Properties

Displays the Joint Properties Dialog Box for the selected joint.

> Note: The old help linked the Properties button to this topic itself; the Joint Properties dialog is documented separately.

Updated to match the current version of HVE.

Human Information Dialog

This dialog is used to define the basic parameters (name, seating location and body description) for a human in the current case.

> Note: As of HVE Version 10,
>
> *new*
>
> humans are added to the case using the GEBOD Human Information dialog (described below), which generates the human data set from the GEBOD body generator. The classic Human Information dialog described first is still displayed when editing a human that was created from the older human database (pre-Version 10 humans). In both dialogs, the body-description controls are disabled if the human already has event output tracks.

Classic Human Information Dialog

Human Name

A user-editable field allowing the user to assign a name to the current human. By default the name is built from the current selections (e.g. "Male Adult Wt% 50 Ht% 50") and is updated automatically as selections change until the user types a custom name. The name must be unique within the case and may not exceed the maximum HVE name length.

Location

Displays a list allowing the user to choose a seat position for the current human. The available positions are Front, Rear and Back rows, each with Right, Center and Left seats (nine positions total). The user may also choose Pedestrian.

Sex

A combo box. The user may select either Male or Female (choices are limited to those available in the human database).

Age

A combo box allowing the user to select Adult, or 12 Year, 9 Year, 6 Year and 3 Year child ages (choices are limited to those available in the database for the selected sex).

Weight Percentile

A combo box containing the available weight percentiles: 2.5, 50 and 97.5 (choices depend on the selected sex and age).

Height Percentile

A combo box containing the available height percentiles: 2.5, 5, 50, 95 and 97.5 (choices depend on the selected sex, age and weight percentile).

GEBOD Human Information Dialog (Version 10 and later)

New humans are added to the current case using this dialog, which builds the human from GEBOD (GEnerator of BOdy Data) regression data rather than from a fixed database of body types.

Human Name

A user-editable field allowing the user to assign a name to the current human.

Location

Same seat-position list as the classic dialog: Front/Rear/Back rows with Right/Center/Left seats, or Pedestrian.

Subject Type

A combo box used to select the GEBOD subject type: Child, Female or Male. A User-defined subject type is also listed but is not yet supported in the current build; selecting it produces a "not yet supported" message and reverts the selection to the previous type.

Basis

A combo box selecting which body measurement(s) the GEBOD data set is based on: Age, Weight, Height or All.

Age

A slider and edit field specifying the subject's age. The Options radio buttons select whether age is entered in Months or Years.

Weight

A slider and edit field specifying the subject's weight. The Options radio buttons select whether the value is entered as a percentile (%-tile) or directly in weight units (e.g. lb).

Standing Height

A slider and edit field specifying the subject's standing height. The Options radio buttons select whether the value is entered as a percentile (%-tile) or directly in length units (e.g. in).

Filename / Select

Intended to display the name of the GEBOD data file used to create a User-defined subject. Because User-defined subjects are not yet supported in the current build, these controls are inactive: the Filename field and Select button are disabled on all code paths, and the Select button performs no action.

Updated to match the current version of HVE.

Human CG Dialog Box

Clicking on the CG of any segment of a human displays this popup dialog, which shows a list of options that can be performed for the selected segment. The dialog title bar shows the name of the selected segment (Pelvis, Abdomen, Chest, Neck, Head, Rt/Lt Upper Leg, Rt/Lt Lower Leg, Rt/Lt Foot, Rt/Lt Upper Arm, Rt/Lt Lower Arm).

This dialog contains the following items:

Inertias... Displays the Inertial Data Dialog Box for the selected segment.

Color... Displays the Color Editor dialog box, with which the user can set the color of the selected segment.

Ellipsoids... Displays the Human Contact Ellipsoids Dialog Box for the selected segment.

Injury Tolerance... Displays the Injury Tolerance Data Dialog Box.

Joints... Displays the Joint Data Dialog Box for the joints attached to the selected segment.

Cancel Closes the popup without making a selection.

Updated to match the current version of HVE.

Human Joint Properties Dialog Box

Each joint is defined by a number of physical properties. This dialog is used to view and edit those properties; it is opened with the Properties button in the Joint Data Dialog Box. The dialog title bar shows the current human's name and the selected joint. Except for the joint type, each property is entered separately for rotation about the joint's i, j and k axes.

This dialog box contains the following items:

Joint Type

Ball and Socket Sets the joint type to ball and socket.

Hinge Sets the joint type to hinge.

Rotation About (i Axis / j Axis / k Axis)

Stop Angle for + Axis Rotation (deg) The angle at which the joint stop is applied for positive i, j and k segment rotations.

Stop Angle for - Axis Rotation (deg) The angle at which the joint stop is applied for negative i, j and k segment rotations.

Stop Elasticity For + Axis Rotation (in-lb/deg) Joint stop linear elastic property for positive rotations about the i, j and k axes.

Stop Elasticity For - Axis Rotation (in-lb/deg) Joint stop linear elastic property for negative rotations about the i, j and k axes.

Stop Energy Dissipation Ratio of dissipated to total energy of the joint stop.

Linear Elastic Coefficient (in-lb/deg) Joint linear elastic property during the normal range of motion for rotations about the i, j and k axes.

Quadratic Elastic Coefficient (in-lb/deg^2) Joint quadratic elastic property during the normal range of motion for rotations about the i, j and k axes.

Cubic Elastic Coefficient (in-lb/deg^3) Joint cubic elastic property during the normal range of motion for rotations about the i, j and k axes.

Damping Constant (in-lb-sec/deg) Joint damping property during the normal range of motion for rotations about the i, j and k axes.

Full Damping Angular Velocity (deg/sec) Angular velocity required to achieve full joint damping.

Joint Injury Tolerance

Max Angle For + Axis Rotation (deg) The positive joint angle which, if exceeded, is predicted to cause injury to the joint.

Max Angle For - Axis Rotation (deg) The negative joint angle which, if exceeded, is predicted to cause injury to the joint.

All values are range-checked when OK is pressed; out-of-range values must be corrected before the dialog will close.

Updated to match the current version of HVE.

Human Material Properties Dialog Box

This dialog is used to view and edit the human material assigned to the current contact ellipsoid (see the Human Contact Ellipsoids Dialog Box). Material properties may be edited directly, and material files may be opened and saved for later application. Each numeric property is edited either with its slider or by typing into the adjacent edit field.

This dialog box contains the following items:

Human Material Graph

The area at the top of the dialog displays a plot of the material's force-deflection curve, computed from the current property values (constant, linear, quadratic and cubic stiffness terms, limited by the maximum force/deflection and unloading slope). Press Apply to redraw the graph after editing values.

Material Name

User-editable material name.

Constant (lb)

Force required to initiate deflection.

Linear Stiffness (lb/in)

Linear material deformation coefficient.

Quadratic Stiffness (lb/in^2)

Quadratic material deformation coefficient.

Cubic Stiffness (lb/in^3)

Cubic material deformation coefficient.

Damping Constant (lb-sec/in)

Material velocity-dependent deformation constant.

Friction Constant

Inter-segment friction coefficient (dimensionless).

Maximum Force (lb)

Force at which the 3rd order force-deflection relationship is abandoned.

Maximum Deflection (in)

Deflection at which the 3rd order force-deflection relationship is abandoned.

Unloading Slope (lb/in)

Linear unloading slope, applied beginning at maximum deflection.

Max Deff / Time Step (in)

Maximum allowed change in deflection (penetration) per integration time step. This limits how far the contact deflection may advance in a single simulation time step.

Print

Prints the current graph.

Apply

Redraws the graph using the current values.

New

Resets all properties to the built-in "Default Human Material" values (Constant 0.0 lb, Linear Stiffness 982.8 lb/in, Quadratic Stiffness -18.0 lb/in², Cubic Stiffness -3.4 lb/in³, Damping Constant 0.55 lb-sec/in, Friction 0.5, Maximum Force 1580.0 lb, Maximum Deflection 2.5 in, Unloading Slope 740.0 lb/in, Max Deff/Time Step 4.0 in) and redraws the graph.

Open

Opens an existing human material file (HVE Material Files, *.matl) and loads its values into the dialog.

Save As

Saves the current settings in a human material file (*.matl).

Updated to match the current version of HVE.

Selected Humans & Vehicles Dialog Box

This is a modeless, resizable dialog box that displays the humans and vehicles selected for the current event. The dialog title bar shows the name of the current event.

Humans & Vehicles Tree

The humans and vehicles in the current event are shown in a tree control rather than a flat list:

- Each root-level entry is a (non-trailer) vehicle or an independent human (e.g. a pedestrian).
- Trailers and other towed vehicles appear as children of their parent (tow) vehicle.
- Humans connected to a vehicle (e.g. occupants) appear as children of that vehicle; unconnected humans appear at the root level.

Clicking an entry in the tree makes that human or vehicle the currently selected object for the event: the event editor view, and any open position/velocity dialog, are updated to reflect the newly selected object.

If no humans or vehicles have been selected for the event, a "No Humans or Vehicles Selected" message is displayed instead.

Updated to match the current version of HVE.

Environment

Dialog and feature reference for the HVE **Environment** area, converted from the on-line help. Part of the HVE Manual.

Pages

- Box Editor Dialog
- Cone Editor Dialog
- Contact Surfaces Dialog
- Cylinder Editor Dialog
- Environment Material Properties Dialog
- Environment Information Dialog
- Lining Friction Properties Dialog
- Material Properties Dialog
- New Ellipsoid Dialog
- Sphere Editor Dialog
- Surface Editor Dialog

Box Editor Dialog

The Box Object Tool allows the user to create and edit 3-D boxes. Boxes are useful for creating buildings, sidewalks, curbs and other box-shaped objects. The Box Editor dialog displays information about the current Box object.

The dialog is divided into a position/orientation group on the left and a shape group on the right. Position labels display the units for the current unit system (e.g. ft, deg); the labels are refreshed from the current language and unit settings whenever the dialog is activated, so changing the unit options updates the displayed units. Values typed into the dialog are applied to the selected box when the Apply button is pressed (pressing Enter is equivalent to Apply).

Coordinates X

Displays and allows editing of the selected object's local or global X coordinate.

Coordinates Y

Displays and allows editing of the selected object's local or global Y coordinate.

Coordinates Z

Displays and allows editing of the selected object's local or global Z coordinate.

Roll

Displays and allows editing of the selected object's local or global Roll orientation (degrees).

Pitch

Displays and allows editing of the selected object's local or global Pitch orientation (degrees).

Yaw

Displays and allows editing of the selected object's local or global Yaw orientation (degrees).

Global/Local

Combo box selecting whether the coordinate and angle values are displayed and entered in the Global (world) reference frame or the box's Local reference frame. Options: *Global*, *Local*. Default: *Global*.

Width

Allows the user to edit the box's base width in the local y' direction.

Height

Allows the user to edit the box's height in the local z' direction.

Note: On Apply, the box height is not applied from this field. The height is forced equal to the **Length** value, so the box always renders with its height equal to its length. The Height field value entered here is not independently applied.

Length

Allows the user to edit the box's length in the local x' direction.

Bind to

Radio buttons selecting what the coordinate fields are bound to when picking and editing:

- **Object** — the box as a whole (default).
- **Face** — an individual face of the box.
- **Vertex** — an individual vertex.

Apply

Applies the values in the dialog to the selected box and registers the change with the undo/redo system, so the edit can be undone or redone. Pressing Enter (OK) also applies; pressing Esc (Cancel) is ignored — the dialog remains open.

Updated to match the current version of HVE.

Cone Editor Dialog

The Cone Object Tool allows the user to create and edit 3-D cones. Cones are useful for creating highway delineator cones and simple trees. The Cone Editor dialog box displays information about the current cone object.

The dialog is divided into a position/orientation group on the left and a shape group on the right. Position labels display the units for the current unit system (e.g. ft, deg); the labels are refreshed from the current language and unit settings whenever the dialog is activated, so changing the unit options updates the displayed units. Values typed into the dialog are applied to the selected cone when the Apply button is pressed (pressing Enter is equivalent to Apply).

Coordinates X

Displays and allows editing of the selected object's local or global X coordinate.

Coordinates Y

Displays and allows editing of the selected object's local or global Y coordinate.

Coordinates Z

Displays and allows editing of the selected object's local or global Z coordinate.

Roll

Displays and allows editing of the selected object's local or global Roll orientation (degrees).

Pitch

Displays and allows editing of the selected object's local or global Pitch orientation (degrees).

Yaw

Displays and allows editing of the selected object's local or global Yaw orientation (degrees).

Global/Local

Combo box selecting whether the coordinate and angle values are displayed and entered in the Global (world) reference frame or the cone's Local reference frame. Options: *Global*, *Local*. Default: *Global*.

Radius

Allows editing of the cone's base (bottom) radius.

Length

Allows editing of the cone's length (the height of the cone from base to apex).

Bind to

Radio buttons selecting what the coordinate fields are bound to when picking and editing:

- **Object** — the cone as a whole (default).
- **Face** — an individual face of the cone.
- **Vertex** — an individual vertex.

Apply

Applies the values in the dialog to the selected cone and registers the change with the undo/redo system, so the edit can be undone or redone. Pressing Enter (OK) also applies; pressing Esc (Cancel) is ignored — the dialog remains open.

Updated to match the current version of HVE.

Contact Surfaces Dialog

The current vehicle may include contact surfaces used for simulating interaction forces between the vehicle and its occupants or pedestrians.

Contact surfaces are planes defined by 3 corners (the fourth corner is automatically assigned by assuming a parallelogram). Contact surfaces are created using the Contact Surfaces dialog box.

This dialog is used for assigning contact surfaces to the current vehicle. A vehicle may have up to 25 contact surfaces.

This dialog contains the following parameters:

Contact Surface

Select the contact surface from the combo box to edit its properties.

Location

Radio buttons assigning the location attribute of the current surface:

- **Interior** — assigns the Interior attribute, used by the simulation model to identify surfaces on the vehicle's interior (occupant simulation).
- **Exterior** — assigns the Exterior attribute, used by the simulation model to identify surfaces on the vehicle's exterior (pedestrian simulation).

Bind Material To

Radio buttons determining whether the material is associated with individual vertices, with polygonal areas, or with the whole group. The setting applies to the vehicle's contact-surface set as a whole:

- **Vertex** — the material is bound to each vertex.
- **Face** — the material is bound to each face (polygonal area).
- **Group** — the material is bound to the surface group.

These buttons are disabled until at least one contact surface exists.

Corners (Counter-Clockwise)

Assigns the vehicle-fixed x, y, z coordinates (in inches) for the three corners — **First**, **Middle** and **Third** — of the contact surface. The fourth corner is assigned automatically by assuming a parallelogram. The corner coordinates are validated when the surface is saved; invalid (degenerate) coordinates are rejected.

Material Name

Displays the name of the material assigned to the current contact surface (read-only in this dialog; edit it in the Material Properties dialog). Newly added surfaces are assigned the "Default Vehicle Material".

Add

Adds a contact surface. A New Contact Surface dialog prompts for the surface name; the name must be non-empty and unique. The new surface is created with corner coordinates of 0,0,0 and the default vehicle material (linear stiffness 982.8 lb/in, friction 0.5, maximum force 1580 lb, maximum deflection 2.5 in, unloading slope 740 lb/in). No more than 25 surfaces may be added.

Delete Surface

Deletes the current contact surface (after a confirmation prompt).

Material...

Displays the Material Properties Dialog Box for the current contact surface.

OK / Cancel

OK validates the corner coordinates and saves the contact surfaces to the vehicle; Cancel discards the changes.

Updated to match the current version of HVE.

Cylinder Editor Dialog

The Cylinder Object Tool allows the user to create and edit 3-D cylinders. Cylinders are useful for creating telephone poles, signposts and numerous other objects. The Cylinder Editor dialog displays information about the current cylinder object.

The dialog is divided into a position/orientation group on the left and a shape group on the right. Position labels display the units for the current unit system (e.g. ft, deg); the labels are refreshed from the current language and unit settings whenever the dialog is activated, so changing the unit options updates the displayed units. Values typed into the dialog are applied to the selected cylinder when the Apply button is pressed (pressing Enter is equivalent to Apply).

Coordinates X

Displays and allows editing of the selected object's local or global X coordinate.

Coordinates Y

Displays and allows editing of the selected object's local or global Y coordinate.

Coordinates Z

Displays and allows editing of the selected object's local or global Z coordinate.

Roll

Displays and allows editing of the selected object's local or global Roll orientation (degrees).

Pitch

Displays and allows editing of the selected object's local or global Pitch orientation (degrees).

Yaw

Displays and allows editing of the selected object's local or global Yaw orientation (degrees).

Global/Local

Combo box selecting whether the coordinate and angle values are displayed and entered in the Global (world) reference frame or the cylinder's Local reference frame. Options: *Global*, *Local*. Default: *Global*.

Radius

Allows the user to edit the cylinder's radius.

Length

Allows the user to edit the cylinder's length (the height of the cylinder along its axis).

Bind to

Radio buttons selecting what the coordinate fields are bound to when picking and editing:

- **Object** — the cylinder as a whole (default).
- **Face** — an individual face of the cylinder.
- **Vertex** — an individual vertex.

Apply

Applies the values in the dialog to the selected cylinder and registers the change with the undo/redo system, so the edit can be undone or redone. Pressing Enter (OK) also applies; pressing Esc (Cancel) is ignored — the dialog remains open.

Updated to match the current version of HVE.

Environment Material Properties Dialog

This dialog displays the properties of the selected environment (terrain) material. Most numeric parameters are edited either by dragging a slider or by typing directly into the adjacent edit field; the graph is updated when Apply is clicked.

This dialog contains the following items:

Environment Material Graph

Graph showing the relation between force and deflection for the current material parameters.

Material Name

User-editable material name for the terrain at X, Y.

Friction Multiplier

Friction multiplier at X, Y. Dimensionless; valid range 0.0–2.0. Default is 1.0.

Macrotexture

Surface macrotexture depth, in inches (range 0.0–1.0 in). Used by tire-road friction (e.g., wet-road) calculations.

This entry replaces the Clay Content field found in earlier versions of this dialog.

Force-Deflection Properties

Constant

Force required to initiate deflection at X, Y (lb; range 0–10,000). Default is 5,000 lb.

Linear Stiffness

Linear material deformation coefficient at X, Y (lb/in; range 0–1,000,000). Default is 50,000 lb/in.

Quadratic Stiffness

Quadratic material deformation coefficient at X, Y (lb/in^2; range -2,500 to 2,500). Default is 1,000 lb/in^2.

Cubic Stiffness

Cubic material deformation coefficient at X, Y (lb/in^3; range -100 to 3,500). Default is 1,000 lb/in^3.

Damping Constant

Material velocity-dependent deformation constant at X, Y (lb-sec/in; range 0.0–5.0). Default is 0.

Unloading Slope

Linear unloading slope beginning at maximum deflection (lb/in; range 0–10,000,000). Default is 1,000,000 lb/in.

Soil Properties

Bekker Soil Exponent, N

Soil deformation exponent for sinkage calculations (dimensionless; range 0.0–1.0). Default is 0.

Frictional Soil Mod, Kphi

Frictional soil modulus for sinkage calculations (lb/in^(N+1); range 0–150). Default is 0.

Cohesive Soil Mod, Kc

Cohesive soil modulus for sinkage calculations (lb/in^(N+2); range 0–40). Default is 0.

Moisture Content

Fraction of moisture in the soil (%/100; range 0.0–1.0). Default is 0.

Buttons

Print

Prints the currently displayed graph.

Apply

Validates the entered values and redraws the graph with the modified values.

New

Resets the dialog to the default environment material ("Default Environment Material") with the default values listed above.

Open...

Opens an environment material from an HVE Material file (*.matl) in the environment materials directory.

Save As...

Saves the current material settings to an HVE Material file (*.matl) for later reuse.

OK / Cancel

OK validates and accepts the material; Cancel discards the changes.

Updated to match the current version of HVE.

Environment Information Dialog

A new environment is added to the current case using the Environment Information dialog. The dialog has three top-level fields — *Environment Name*, *Date of Crash* and *Time of Crash* — followed by a tabbed property sheet and the standard OK/Cancel buttons.

The property sheet may contain up to five tabs — **Terrain**, **Sky**, **Physical**, **Location** and **Traffic Signals**. Which tabs appear depends on the run mode and viewer type:

- The **Terrain** tab is always present.
- In HVE-3D, all five tabs are shown.
- With a 3-D camera viewer, the **Sky**, **Location** and **Traffic Signals** tabs are added.
- In HVE-2D, only the **Terrain** tab is present. The **Physical** tab (Wind Speed, Wind Direction, Temperature, Barometric Pressure, etc.) is present only in HVE-3D, so those fields are simply not shown in HVE-2D — they are not displayed read-only.

Top-Level Fields

Environment Name

A user-editable field allowing the user to assign a name to the current environment.

Date of Crash

The date of the crash or test being simulated. The entry format follows the user's date-style preference; the field label displays the expected format as either *(mm/dd/yy)* (US) or *(dd/mm/yy)* (European). The displayed year uses a 2-digit format.

Time of Crash (24 Hr)

The standard time of day (24-hour military time) for the crash or test being simulated.

Terrain Tab

The Terrain tab selects and configures the environment geometry or aerial photo.

Type

Radio buttons selecting the kind of environment surface:

- **None** — no terrain or aerial image.
- **Terrain Map (Geometry)** — a 3-D geometry file.
- **Aerial Photo (Bitmap)** — an aerial photograph displayed on a ground polygon.

Selecting a type enables the corresponding *Terrain Map* or *Aerial Photo* group and disables the other.

Terrain Map group

- **Filename** — an editable field showing the terrain geometry file in use.
- **Open...** — opens an existing geometry file. The file-type filter offers HVE Geometry Files (*.h3d), Inventor Files (*.iv), VRML Files (*.wrl) and OBJ Files (*.obj); when the DXF translator feature is licensed, DXF Files (*.dxf) and DWG Files (*.dwg) are also offered.
- **Save As...** — saves the current environment geometry to a new HVE Geometry file (*.h3d). Only H3D is supported for saving; texture pathnames are cleared/stored relative to the environment textures directory. Enabled only when geometry is in use.
- **Remove** — clears the current terrain filename and resets the Type to None. Enabled only when a filename is present.
- **Use As Default** — checkbox marking the current terrain file as the default for new environments (not available when editing an existing environment).

File Import Options

Shown for non-H3D geometry (e.g. DXF/DWG/IV/WRL/OBJ); disabled for native *.h3d files:

- **Flip About X-Axis** — checkbox to flip the imported geometry about the X axis.
- **Scale Factor** — numeric scale applied to the imported geometry.
- **Default Type** — combo box assigning the default polygon/object type for the imported geometry. Options: *Human*, *Vehicle*, *Road*, *Friction Zone*, *Curb*, *Water*, *Other*.

Aerial Photo group

- **Filename** — an editable field showing the aerial image file in use.
- **Open...** — opens an aerial image. Supported formats: BMP (*.bmp), TIF (*.tif), GIF (*.gif), RGB (*.rgb) and JPEG (*.jpg/*.jpeg). The image's ground coordinates are set from the image aspect ratio.
- **Remove** — clears the current aerial filename and resets the Type to None. Enabled only when a filename is present.
- **Use As Default** — checkbox marking the current aerial image as the default for new environments (not available when editing an existing environment).

Sky Tab

The Sky tab configures the sky image, sky dome and fog. (Shown only in 3-D run modes or with a 3-D camera viewer.)

- **Ambient Light Intensity** — slider and edit field (0.0–1.0).
- **Use Sky Image** — checkbox enabling a sky/backdrop image. When checked, a **Filename** field, **Open...** and **Remove** buttons, and a **Use As Default** checkbox become available. Sky images use the same bitmap formats as aerial photos.
- **Use Sky Dome** — checkbox (available only when a sky image is in use) with a **Sky Dome Rotation** field.
- **Fog Type** — combo box: *None*, *Haze*, *Fog*, *Smoke*. Selecting any type other than None enables the **Visibility** field.
- **Set Sky Color...** — opens a color editor for the background/sky color.

Physical Tab

The Physical tab holds the atmospheric and coordinate-system parameters. It is present only in HVE-3D.

Angle of X Axis (deg)

The angle of the user-defined earth-fixed coordinate system relative to true north. Valid range is -360 to +360 degrees.

Wind Speed

The ambient wind velocity (displayed in the current user velocity unit, e.g. mph).

Wind Dir. (from X Axis, deg)

The ambient wind direction, measured from the earth-fixed X axis. Valid range is -360 to +360 degrees.

Barometric Pressure

The ambient barometric pressure.

Temperature

The ambient temperature.

Gravity

The local acceleration of gravity.

Location Tab

Current Location

A drop-down combo box that selects an existing location from the location database. Selecting a location fills in the Latitude, Longitude and GMT fields from that database entry.

Latitude (dd.mm.ss)

Used to define the global latitude, entered in degrees.minutes.seconds. N and S denote north and south latitudes, respectively.

Longitude (dd.mm.ss)

Used to define the global longitude, entered in degrees.minutes.seconds. E and W denote east and west longitudes, respectively.

GMT (+/-24 Hr)

(Also called UTC offset.) The difference between the local standard time and the time at zero longitude. West longitudes are negative (e.g., New York City is -5 hours).

New Location / Add New Location

To add a location to the database, type its name into the **New Location** edit field and click **Add New Location**. A duplicate name is rejected. The new location is added to the Current Location combo and selected (with empty Latitude/Longitude and GMT 0), ready for its coordinates to be entered. (Saving the page also updates an existing database entry in place if its name matches.)

Traffic Signals Tab

The Traffic Signals tab configures the timing of traffic signals placed in the environment. (Shown in 3-D run modes or with a 3-D camera viewer.)

- **Traffic Signals List** — list of signals in the environment; select one to edit its timing.
- **Type** / **Layout** — read-only fields describing the selected signal.
- **Is Active** — checkbox enabling the selected signal.
- **Repeating** — checkbox for a repeating signal cycle.
- **Signal Timing** — a radio choice between **Start Time** (with a start-time edit field) and **Follow** (with a combo selecting the signal to follow plus an **Overlap** field).

OK / Cancel

OK validates each tab in turn and accepts the entered environment information; Cancel discards the changes.

Updated to match the current version of HVE.

Lining Friction Properties Dialog

Brake factor is heavily influenced by the friction coefficient between the lining material and the rotor or drum. Lining friction, in turn, is influenced by temperature and sliding velocity at the interface between the lining and rotor or drum. The HVE Brake Designer allows the user to directly study these influences by allowing the user and/or simulation model to determine the correct value of lining friction as a function of brake temperature and sliding velocity.

The dialog title includes the current brake design type (e.g., "Pad/Lining Friction Properties: Duo Servo Brake").

This dialog box displays the following items:

Lining Friction Graph

A plot of pad/lining friction vs. temperature. One curve is drawn for each row of the sliding-speed table (legend "Sp -1", "Sp -2", ...); each curve is the lining temperature-friction table scaled by that speed's friction multiplier. The graph is redrawn when Apply is clicked.

Friction vs. Temperature Table

A two-column data grid defining lining friction as a function of temperature:

- **Lining Temp** — brake lining temperature (degrees F; normal range -100 to 800).
- **Lining Friction** — friction coefficient at that temperature (dimensionless; normal range 0.2–0.6).

Up to 6 rows may be entered. Rows are sorted automatically, empty rows are stripped, and duplicate temperature entries are rejected. An empty row is allowed, but not an empty cell within a row.

Friction Multiplier vs. Sliding Speed Table

A two-column data grid defining the velocity sensitivity of lining friction:

- **Sliding Speed** — sliding velocity at the lining/rotor (or drum) interface (in/sec; normal range 0–1,200).
- **Friction Multiplier** — multiplier applied to the temperature-based friction at that speed (dimensionless; normal range 0.50–2.0).

Up to 6 rows may be entered, with the same sorting, empty-cell and duplicate-row checks as the temperature table.

Print

Prints the current graph.

Apply

Validates the table entries, saves them and redraws the graph using the latest data.

OK / Cancel

OK validates and accepts the tables; Cancel discards the changes.

Updated to match the current version of HVE.

Material Properties Dialog

This dialog box allows the user to review and edit the material physical parameters associated with the current vehicle contact surface (interaction between the selected source and target segments). The dialog also includes a graph of the force-deflection relationship for the current parameters. Each numeric parameter may be edited either by dragging its slider or by typing directly into the adjacent edit field.

Note: The old help described these parameters as properties of "the terrain at X,Y"; they are in fact the properties of the selected vehicle contact-surface material.

This dialog contains the following parameters:

Material Properties Graph

Graph of force vs. deflection for the current material parameters. It is redrawn when Apply is clicked.

Material Name

A user-editable name describing the material assigned to the current contact surface.

Constant

The force required to initiate deflection (lb; range 0–5,000). Default is 0.

Linear Stiffness

The first-order force-deflection coefficient (lb/in; range -1,200 to 5,000). Default is 982.8 lb/in.

Quadratic Stiffness

The second-order force-deflection coefficient (lb/in²; range -2,500 to 2,500). Default is -18.0 lb/in².

Cubic Stiffness

The third-order force-deflection coefficient (lb/in³; range -100 to 3,500). Default is -3.4 lb/in³.

Damping Constant

The velocity-dependent force contribution (lb-sec/in; range 0.0–5.0). Default is 0.55 lb-sec/in.

Friction Constant

Friction coefficient multiplier for the contact surface (dimensionless; range 0.0–2.0). Default is 0.5.

Maximum Force

The maximum (saturation) force the material can develop (lb; range 0–1,000,000). Default is 1,580 lb.

Maximum Deflection

The deflection at which maximum force is reached (in; range 0–50). Default is 2.5 in.

Unloading Slope

The first-order unloading force-deflection coefficient, applied beginning at maximum deflection (lb/in; range 0–1,000,000). Default is 740 lb/in.

Max Defl / Time Step

The maximum change in deflection (penetration) allowed during a single integration time step (in; range 0–30). Default is 4.0 in.

Print

Prints the displayed graph.

Apply

Validates the entered values, saves them to the current material and redraws the graph with the new values.

New

Resets the dialog to the "Default Vehicle Material" using the default values listed above.

Open...

Opens a material from an HVE Material file (*.matl) in the vehicle materials directory.

Save As...

Saves the current settings to an HVE Material file (*.matl) for later reuse.

OK / Cancel

OK validates and accepts the material for the current contact surface; Cancel discards the changes.

Updated to match the current version of HVE.

New Ellipsoid Dialog

This dialog is used to add a new contact ellipsoid to the currently selected human. It is displayed by the Add button in the human's Contact Ellipsoids dialog.

Enter a name for the new Ellipsoid

User-editable name for the new ellipsoid. The name must be 30 characters or fewer; a longer name produces a "name too long" error message and the dialog remains open. The name must also be unique among the human's existing ellipsoids — a duplicate name is rejected after the dialog closes.

OK

Accepts the name and creates the new ellipsoid, provided the name is valid and the human does not already have the maximum of 3 contact ellipsoids (an error message is displayed if the maximum is exceeded).

Cancel

Closes the dialog without adding an ellipsoid.

Updated to match the current version of HVE.

Sphere Editor Dialog

The Sphere Object Tool allows the user to create and edit 3-D spheres. Spheres are useful for creating spherical or ellipsoidal shaped objects. The Sphere Editor dialog displays information about the current sphere object.

The dialog is divided into a position/orientation group on the left and a shape group on the right. Position labels display the units for the current unit system (e.g. ft, deg). Values typed into the dialog are applied to the selected sphere when the Apply button is pressed (pressing Enter is equivalent to Apply).

Coordinates X

Displays and allows editing of the selected object's local or global X coordinate.

Coordinates Y

Displays and allows editing of the selected object's local or global Y coordinate.

Coordinates Z

Displays and allows editing of the selected object's local or global Z coordinate.

Roll

Displays and allows editing of the selected object's local or global Roll orientation (degrees). Because a sphere is rotationally symmetric, orientation changes have no visible effect on the sphere's geometry itself, but they are stored with the object.

Pitch

Displays and allows editing of the selected object's local or global Pitch orientation (degrees).

Yaw

Displays and allows editing of the selected object's local or global Yaw orientation (degrees).

Global/Local

Combo box selecting whether the coordinate and angle values are displayed and entered in the Global (world) reference frame or the sphere's Local reference frame. Options: *Global*, *Local*. Default: *Global*.

Radius

Allows editing of the sphere's radius.

Bind to

Radio buttons selecting what the coordinate fields are bound to when picking and editing:

- **Object** — the sphere as a whole (default).
- **Face** — an individual face of the sphere.
- **Vertex** — an individual vertex.

Apply

Applies the values in the dialog to the selected sphere and registers the change with the undo/redo system, so the edit can be undone or redone. Pressing Enter (OK) also applies; pressing Esc (Cancel) is ignored — the dialog remains open.

Updated to match the current version of HVE.

Surface Editor Dialog

The Surface Editor is used for entering and editing 3-D surfaces. When the Surface tool is selected from the toolbar, the editor starts in Vertex mode so the vertices of a new surface can be entered.

Note: In HVE-2D, the Roll and Pitch angle fields are displayed read-only.

This dialog contains the following items:

Coords (ft) — X, Y, Z

The coordinates of the current vertex (or of the surface object, in Object mode), in feet.

Angle (deg) — Roll, Pitch, Yaw

The orientation of the current selection, in degrees. The angle fields are active only when an object (rather than an individual face or vertex) is being edited.

Global/Local

A combo box selecting the coordinate reference used for the entered values: **Global** (earth-fixed) or **Local** (relative to the surface object). Global is the default.

Mode

Radio buttons selecting the current pick/edit mode. Only the modes valid for the current selection are enabled:

- **Object** — pick and move/rotate the entire surface object. Enables the Add button so additional polygons can be added.
- **Face** — pick individual polygons of the surface. Enables the Rev Nrml button.
- **Vertex** — pick and edit individual vertices. This is the initial mode when creating a new surface.
- **Subdivide** — scissors mode used to split (subdivide) the surface; the split is performed when Apply is clicked. *This mode is new and was not documented in earlier help.*

The "Bind To Object/Face/Vertex" radio buttons documented in earlier versions are no longer part of this dialog (they remain in the Cone/Cylinder editors).

Add

Begins adding a new polygon to the active surface. Enabled while in Object edit mode.

End

Closes (ends) the polygon currently being entered. The button is disabled as soon as it is clicked; Add is re-enabled if the editor is in Object edit mode.

Rev Nrml

Reverses the surface normal of the picked face. Enabled only in Face mode.

Dec/Tes

Displays the Decimate/Tessellate dialog, used to reduce (decimate) or refine (tessellate) the surface mesh.

This button is new and was not documented in earlier help.

Apply

Selecting Apply causes the entered parameters to be accepted, and the first vertex will appear in the views at the specified X, Y and Z coordinate. A small, bright marker is displayed at the location of the first vertex. In Subdivide mode, Apply performs the surface split. Surface Editor actions applied this way are registered with the Undo/Redo manager.

Updated to match the current version of HVE.

Events & Driver Controls

Dialog and feature reference for the HVE **Events & Driver Controls** area, converted from the on-line help and verified against the current release. Part of the HVE Manual.

Pages

- Contacts Dialog Box
- Driver Controls
- Driver Controls Path Follower Method
- Driver Controls Wheel Data
- Driver Controls Brake
- Driver Controls Throttle
- Driver Controls Gear
- Driver Controls Filter
- Driver Controls Path Follower
- Driver Controls Speed Follower
- Event Information Dialog Box
- Event Setup Menu
- Inter-Vehicle Connections Dialog
- Position/Velocity Dialog Box
- Simulation Controls Dialog Box

Contacts Dialog Box

The Contacts dialog allows the user to select the allowable interaction between human ellipsoids and vehicle contact surfaces. For example, there is little chance of a human pedestrian's pelvis interacting with the vehicle's interior contact surfaces (e.g., the seat) during the simulation. Therefore, it makes little sense to perform force calculations for this ellipsoid/contact surface pair. By selecting only those contact surfaces having a chance of interaction, far fewer calculations need to be performed. As a result, the calculation time can be reduced significantly.

The contents of the Contacts dialog box are as follows.

Object

A read-only field displaying the name of the source object (the currently selected human or vehicle), and a combo box listing all humans and vehicles in the current event. Select the target object from this combo box; the Target(s) list is refreshed for the chosen object.

Source(s)

A multiple-selection list box containing all the contacts (human ellipsoids or vehicle contact surfaces) defined for the source object. **Select All** and **Deselect All** buttons below the list select or clear all source contacts.

Target(s)

A multiple-selection list box containing all the contacts (human ellipsoids or vehicle contact surfaces) defined for the target object. **Select All** and **Deselect All** buttons below the list select or clear all target contacts.

Combined Material Properties

Some simulation models define the human ellipsoid and vehicle contact surface material properties according to the sole properties of the ellipsoid or contact surface; other simulations define the material properties as a combined property shared by the two interacting objects. This group is enabled only for calculation methods that use combined material properties. It contains the following items:

- **For / And** — read-only fields identifying the source contact and target object for which the combined material is being assigned.
- **Segment(s)** — A multiple-selection list box containing the contacts defined for the target object; only those contacts selected in the Target(s) list are selectable in this list box. **Select All** and **Deselect All** buttons select or clear all segments.
- **Current Material** — A read-only field displaying the name of the combined material currently assigned to the selected source/target pair.
- **Edit ...** — Displays the Combined Material Properties dialog, used to view and edit the force-deflection and friction properties of the combined material for the selected pair.

OK / Cancel

OK saves the contact selections to the current event; **Cancel** discards all changes.

Updated to match the current version of HVE.

Driver Controls

This dialog box is used to assign Steering, Braking, Throttle, Gear selection, HVE Driver (path/speed follower), Wheel Data and Lights data for the selected vehicle.

This dialog box allows the user to enter parameters which describe how the driver attempted to control the vehicle. It is a tabbed property sheet; the pages that appear depend on the capabilities of the current event's calculation method and on the selected vehicle:

- **Steer** — steer table (this topic, below)
- **Brake** — see Driver Controls Brake
- **Throttle** — see Driver Controls Throttle
- **Gear** — see Driver Controls Gear
- **HVE Driver** (path follower) — see Driver Controls Path Follower
- **Wheel Data** — see Driver Controls Wheel Data
- **Lights** — light systems activation (only shown when the calculation method supports light systems and the vehicle has lights defined). Select a light from the Light Name List, check *Is Active*, and choose the activation method: *Use Driver Controls* or *User-Entered* start/end time table. For turn signals, the *On/Off Cycle Time (sec)* and *Min Steer Angle (deg)* may also be entered.

Two table-editing buttons appear at the bottom of the sheet for the Steer, Brake and Throttle table pages:

- **Copy Cell** — copies the value in column 1 of the current row to all remaining columns of the row.
- **Copy Row** — inserts a duplicate of the current table row.

Steer

Applies steer angles that attempt to steer the vehicle.

This page enables the user to enter data for the following items.

Table

Selects the type of steer table (the available choices depend on the calculation method):

- **At Steering Wheel** — This method allows the user to enter a table of steering wheel angle versus time. The entered value is divided by the axle's steering gear ratio to determine the nominal steer angle at the tire.
- **At Axle** — This method allows the user to enter a table of steer angle at each tire of a steerable axle versus time. The entered value is applied directly to the tire, and is unaffected by any roll steer or toe-in. The table contains a pair of columns (right/left) for each steerable axle.

Data Grid

A table of steering angle versus time. Rows may be added, duplicated and edited directly in the grid.

Use Ackermann Steering

When checked, the simulation applies Ackermann geometry to the steer angles, so that the inside and outside tires of a steerable axle are steered through slightly different angles.

Updated to match the current version of HVE.

Driver Controls Path Follower Method

The Method tab of the HVE Driver (Path Follower) page selects how the path correction is accomplished. Two methods are defined:

Variable Steering

The path correction is accomplished by means of a steering correction. The user supplies the following data:

- **Initial Angle (deg)** — Initial steering wheel angle at driver start time.
- **Max Velocity (deg/sec)** — Limit on steering wheel velocity (how fast the driver can turn the wheel).
- **Correction Factor (deg/sec)** — Amount of steering correction per unit of path error (steering correction rate).
- **Correction Damp (deg)** — Steering correction damping, used to limit steering activity.

Variable Torque

The path correction is accomplished by means of a torque application at the steering wheel. In this case the user supplies the following data:

- **Initial Steering Torque (in-lb)** — Initial steering wheel torque at driver start time.
- **Max Steering Torque (in-lb)** — Limit on steering wheel torque.
- **Torque Correction Factor (in-lb/in)** — Amount of steering torque correction per unit of path error.
- **Torque Damping (in-lb-sec/in)** — Torque correction damping, used to limit steering activity.

> **Note:** The Variable Torque option is currently disabled in the user interface; Variable Steering is the available path follower method.

Updated to match the current version of HVE.

Driver Controls Wheel Data

Applies constant wheel forces and steer angles.

The Wheel Data page is available for reconstruction models. This page allows the user to enter the following information.

Pre-Impact

Total Lock-up (%/100) The entered value is multiplied by the average tire-ground friction coefficient to determine the total vehicle deceleration between the user-entered Begin Braking and Impact positions. This value is relevant only if the user has supplied a Begin Braking position for the current vehicle.

Post-Impact

Rot/Lat Skidding This check box may be used by reconstruction models to trigger special calculations for vehicles that spin (rotate/laterally skid) between separation and rest.

For each axle (Axle 1, Axle 2 and Axle 3, as applicable to the current vehicle), the following post-impact values are entered:

Right Lock-up (%/100) The wheel lock-up is multiplied by the available friction force to determine the average longitudinal force at the right wheel. The entered value should not account for lateral skidding; the program's tire model will determine the tire slip angle and account for the force associated with lateral skidding.

Steer (deg) The entered value is used to determine the steer angle at the right wheel. This angle is assumed to remain constant, and applies only during the post-impact phase.

Left Lock-up (%/100) The wheel lock-up is multiplied by the available friction force to determine the average longitudinal force at the left wheel. The entered value should not account for lateral skidding; the program's tire model will determine the tire slip angle and account for the force associated with lateral skidding.

Steer (deg) The entered value is used to determine the steer angle at the left wheel. This angle is assumed to remain constant, and applies only during the post-impact phase.

All values are entered with a slider or by typing directly into the associated edit field.

Updated to match the current version of HVE.

Driver Controls Brake

Applies longitudinal tire forces that attempt to slow the vehicle.

This page enables the user to enter data for the following items.

Table

Selects the type of brake table (the available choices depend on the calculation method):

- **Pedal Force** — This method allows the user to enter a table of brake pedal force versus time. The vehicle's brake system model converts the pedal force to a brake torque, and thus a longitudinal force, at each wheel. This is the only option that engages the vehicle's brake system (and Brake Designer) data.
- **Wheel Force** — This method allows the user to enter a table of brake force (attempted longitudinal force decelerating the vehicle) versus time at each wheel. The resulting table determines how much decelerating force is applied at each wheel. The table contains a pair of columns (right/left) for each axle.
- **Available Friction** — This method allows the user to enter a table of available frictional braking force (percentage of the total available frictional force braking the vehicle) versus time at each wheel. The calculations are performed by the simulation model, which multiplies the entered value by the currently available tire friction and vertical tire load. The table contains a pair of columns (right/left) for each axle.

Data Grid

A table of the selected brake quantity versus time. Rows may be added, duplicated and edited directly in the grid. The *Copy Cell* and *Copy Row* buttons at the bottom of the Driver Controls dialog may be used to fill all columns of a row from column 1 and to duplicate rows.

Updated to match the current version of HVE.

Driver Controls Throttle

Applies longitudinal tire forces that attempt to accelerate the vehicle.

This page enables the user to enter data for the following items.

Table

Selects the type of throttle table (the available choices depend on the calculation method):

- **Wide-open Throttle** — This method allows the user to enter a table of percent of wide-open throttle versus time. The vehicle's drivetrain model converts the throttle setting to engine torque, and thus to tractive force at each drive wheel. This option engages the vehicle's engine and drivetrain data.
- **Tractive Effort** — This method allows the user to enter a table of tractive effort (total force accelerating the vehicle) versus time. The resulting table determines how much accelerating force is applied at each drive wheel. The table contains a pair of columns (right/left) for each drive axle.
- **Available Friction** — This method allows the user to enter a table of available friction force (percentage of the total available frictional force accelerating the vehicle) versus time. The calculations are performed by the simulation model, which multiplies the entered value by the currently available tire friction and vertical tire load. The table contains a pair of columns (right/left) for each drive axle.

Data Grid

A table of the selected throttle quantity versus time. Rows may be added, duplicated and edited directly in the grid. The *Copy Cell* and *Copy Row* buttons at the bottom of the Driver Controls dialog may be used to fill all columns of a row from column 1 and to duplicate rows.

Use Clutch/Torque Converter

When checked, the drivetrain model includes the clutch (manual transmission) or torque converter (automatic transmission) when computing the drive torque delivered to the wheels.

Updated to match the current version of HVE.

Driver Controls Gear

Applies gear selections that change the current transmission or differential ratio.

The Gear Selection page is available for simulations. This page allows the user to enter a table of gear selection versus time. Separate tables may be entered for the transmission and the differential.

This page enables the user to enter data for the following items.

Table

Selects which gear selector table is being edited:

- **Transmission** — gear shift table for the vehicle's transmission.
- **Differential** — range shift table for the vehicle's differential. This choice is available only if the vehicle's differential has more than one ratio.

No of Shifts

Specifies the number of gear shifts in the current table (0 to 10).

Time (sec)

Time associated with each gear shift. On leaving the page, the entries are automatically sorted into ascending time order; duplicate shift times are reported as an error.

Gear Selection

The gear selected at each shift time. For the transmission table the available choices depend on the vehicle's transmission type:

- Automatic transmission: *Shift into Neutral*, *Shift into Reverse*, *Shift into Drive*.
- Manual transmission: *Shift into Neutral*, *Shift into Reverse*, and a numbered gear (*Shift into 1st*, *Shift into 2nd*, *Shift into 3rd*, ...) for each forward gear defined for the transmission.

For the differential table the choices are the ratios (ranges) defined for the vehicle's differential.

Updated to match the current version of HVE.

Driver Controls Filter

The Filter tab of the HVE Driver (Path Follower) page contains user-entered parameters that define driver physiological capabilities.

Use Neuro-Muscular Filter

When checked, the driver model's steering output is passed through a neuro-muscular filter defined by the parameters below. When unchecked, the filter parameters are ignored.

Neuro-Muscular Filter Parameters

- **Driver Lag Time (sec)** — Neuro-muscular filter lag time.
- **Driver Lead Time (sec)** — Neuro-muscular filter lead time.
- **Driver Time Delay (sec)** — Neuro-muscular filter time delay.

Each parameter is entered with a slider or by typing directly into the associated edit field.

Updated to match the current version of HVE.

Driver Controls Path Follower

The HVE Driver page allows the vehicle simulation to determine the steering, throttle and braking inputs required to follow a user-defined path (and, optionally, user-defined speeds along the path).

Use Path Follower

When checked, the HVE Driver model is enabled for the current vehicle and the tabs below become available. When unchecked, the driver inputs come from the Steer, Brake and Throttle tables.

Model

Selects the version of the HVE Driver model to use: **Ver. 1** or **Ver. 2**. These radio buttons are enabled only when *Use Path Follower* is checked.

The page contains five tabs:

Path Source

Selects the source of the target path data:

- **Position/Velocity Dialog** — the path is defined by the positions entered in the Position/Velocity Dialog (path points placed in the event editor).
- **Table** — reserved for entering path coordinates in a table. This option is currently disabled.

Driver

Driver properties (each entered with a slider or edit field):

- **Driver Start Time (sec)** — Time at which the driver model begins acting.
- **Driver Sample Interval (sec)** — Interval at which the driver model samples the vehicle's position relative to the path.
- **Driver Preview Time (sec)** — How far ahead of the vehicle (in time) the driver is looking when computing the path correction.
- **Driver Minimum Preview Distance (ft)** — Lower limit on the preview point distance ahead of the vehicle, used at low speeds.
- **Path Error Null Distance (ft)** — Maximum allowable lateral path error; the driver steers to null path errors within this distance.
- **Max Speed Error (mph)** — Allowable difference between the current speed and the desired speed (used by the speed follower).
- **Driver Comfort Level (g)** — Maximum lateral acceleration the driver will tolerate when following the path.

Method

Path correction method (Variable Steering or Variable Torque). See Driver Controls Path Follower Method.

Speed

Speed follower parameters. See Driver Controls Speed Follower.

Filter

Neuro-muscular filter parameters. See Driver Controls Filter.

Updated to match the current version of HVE.

Driver Controls Speed Follower

The Speed tab of the HVE Driver (Path Follower) page controls the speed follower. User-entered velocities at each path position are used to define an attempted speed at each point on the path; the driver model applies throttle and brake pedal inputs to achieve those speeds.

Use Speed Follower

When checked, the speed follower is enabled and the throttle and brake parameters below become available. (The allowable speed error is entered as

Max Speed Error

on the Driver tab.)

Throttle

- **Initial Throttle Pedal (%/100)** — Throttle pedal position at driver start time.
- **Max Throttle Pedal (%/100)** — Maximum allowable throttle pedal position.
- **Throttle Correction (%-sec/100-in)** — Amount of throttle pedal correction per unit of speed error.
- **Throttle Damping** — Throttle correction damping, used to limit throttle activity.

Brake

- **Initial Brake Pedal Force (lb)** — Brake pedal force at driver start time.
- **Max Brake Pedal Force (lb)** — Maximum allowable brake pedal force.
- **Brake Correction (lb-sec/in)** — Amount of brake pedal force correction per unit of speed error.
- **Brake Damping** — Brake correction damping, used to limit braking activity.

Delay To Switch Pedals (sec)

Time required for the driver to move between the throttle pedal and the brake pedal.

Each parameter is entered with a slider or by typing directly into the associated edit field.

Updated to match the current version of HVE.

Event Information Dialog Box

This dialog box is used to create a new event or edit an existing one. It assigns the event's name, selects the humans and vehicles that participate in the event, and chooses the physics program (calculation method) used to execute the event.

Event Name

Editable text field containing the name of the current event. HVE assigns a default name based on the selected objects and calculation method; the name may be edited by the user and is used to identify the event throughout the case.

Humans List

A multiple-selection list containing all humans currently defined in the case. Click a human's name to add it to (or remove it from) the current event. Selected humans appear in the Event Humans and Vehicles list.

Vehicles List

A multiple-selection list containing all vehicles currently defined in the case. Click a vehicle's name to add it to (or remove it from) the current event. Selected vehicles appear in the Event Humans and Vehicles list.

Event Humans and Vehicles

A list displaying the humans and vehicles that have been selected for the current event, in the order they were selected. This order determines the object numbering used by the calculation method.

Calculation Method

A drop-down list of the physics programs (calculation method executables) installed in the calcMethods directory. Select the simulation or reconstruction model to be used for this event. If no calculation methods are found, an error message is displayed. The calculation method cannot be changed after the event has been created.

A status line at the bottom of the dialog prompts the user (e.g., "Select any Human or Vehicle") and reports the current selection state.

> **Note:** The *Browse EXE* button described in earlier versions of this dialog has been removed; calculation methods are now located automatically in the calcMethods directory.

Updated to match the current version of HVE.

Event Setup Menu

The Event Set-up menu contains the following menu items. (Items appear enabled or disabled according to the capabilities of the current event's calculation method.)

Position / Velocity Command (Ctrl+P) Displays the Position/Velocity Dialog Box.

Driver Controls Command (Ctrl+D) Displays the Driver Controls Dialog Box.

Damage Profiles Command (Ctrl+M) Displays the Damage Profiles dialog, used to display and edit the crush damage profile (damage dimensions and location) for the selected vehicle in the current event.

Collision Pulse Command (Ctrl+U) Displays the Collision Pulse Dialog Box.

Vehicle Mesh Command Displays the Vehicle Mesh dialog, used to display and edit the body mesh options (e.g., mesh subdivision) used by DyMESH-based collision simulations for the selected vehicle.

Payload Command Displays the Payload Dialog Box.

Wheels Command (Ctrl+W) Displays the Wheels Properties Dialog Box.

Accelerometers Command Displays the Accelerometers Dialog Box.

Contacts Command (Ctrl+T) Displays the Contacts Dialog Box.

Restraints Assigns restraint system usage parameters to the selected human. This popup menu contains the following items:

- **Airbags (Ctrl+G)** — Displays the Air Bag Restraints Dialog Box.
- **Belts (Ctrl+B)** — Displays the Belts Restraint System Dialog Box.

Signals Command Displays the Event Signals Setup dialog, used to assign traffic signal timing for the current event.

Notes Command Displays the Event Notes dialog, used to enter free-form notes describing the current event.

Updated to match the current version of HVE.

Inter-Vehicle Connections Dialog

The connections between tow vehicles and trailers are displayed and edited using the Inter-Vehicle Connections dialog. Program units for vehicle connection properties are shown with each field. Fields are disabled when the corresponding connection type is

None

.

Front Connection

Type The type of connection on the front of the current vehicle. The allowable types are:

- None
- Hitch
- King Pin
- Fixed Drawbar (pintle eye rigidly attached to the trailer)
- Hinged Drawbar (pintle eye on a hinged drawbar)

Coordinates (in) - x The vehicle-fixed X coordinate of the front connection.

y The vehicle-fixed Y coordinate of the front connection.

z The vehicle-fixed Z coordinate of the front connection.

Rear Connection

Type The type of connection on the rear of the current vehicle. The allowable types are:

- None
- Ball
- Fifth Wheel
- Pintle Hook

Coordinates (in) - x The vehicle-fixed X coordinate of the rear connection.

y The vehicle-fixed Y coordinate of the rear connection.

z The vehicle-fixed Z coordinate of the rear connection.

Radius (in) The moment arm at which the frictional torque acts at the connection between the tow vehicle and trailer.

Friction The friction coefficient at the connection between the tow vehicle and trailer.

Max Articulation Angle (deg) The maximum articulation angle allowable between the tow vehicle and trailer.

Updated to match the current version of HVE.

Position/Velocity Dialog Box

This dialog box allows the user to assign positions and velocities for each human and vehicle in the current event. Positions and velocities may be entered for one or more locations along the object's path, according to the requirements of the event's calculation method.

This dialog box contains the following items.

Path Location

The combo box contains the following items:

- **Initial** — Position and velocity of the selected human or vehicle at the beginning of execution.
- **Begin Perception** — Position and velocity of the selected human or vehicle at the beginning of perception (normally the initial part of the perception/reaction period for a driver about to begin an accident avoidance maneuver).
- **Begin Braking** — Position and velocity of the selected human or vehicle when the brakes are applied.
- **Impact** — Position and velocity of the selected human or vehicle at the time of impact.
- **Separation** — Position and velocity of the selected human or vehicle at the time of separation.
- **Point On Curve** — Position and velocity of the selected human or vehicle on a curved path following separation.
- **End of Rotation** — Position and velocity of the selected human or vehicle at the end of the rotating/lateral skidding phase.
- **Final/Rest** — Position and velocity of the selected human or vehicle at the end of the post-impact path.

Which path locations may be edited depends on the current calculation method; locations not used by the method are disabled.

Position

The Position group contains the following items:

- **X** — Linear X distance from the earth-fixed origin (vehicles and human pedestrians) or vehicle-fixed origin (human occupants).
- **Y** — Linear Y distance from the earth-fixed origin (vehicles and human pedestrians) or vehicle-fixed origin (human occupants).
- **Z** — Linear Z distance from the earth-fixed origin (vehicles and human pedestrians) or vehicle-fixed origin (human occupants).
- **Roll** — Angular displacement about the vehicle-fixed X or human segment-fixed X axis. For trailers and human segments other than the pelvis, these angles are articulation angles relative to the upstream vehicle or human segment.
- **Pitch** — Angular displacement about the vehicle-fixed Y or human segment-fixed Y axis. For trailers and human segments other than the pelvis, these angles are articulation angles relative to the upstream vehicle or human segment.

- **Yaw** — Angular displacement about the vehicle-fixed Z or human segment-fixed Z axis. For trailers and human segments other than the pelvis, these angles are articulation angles relative to the upstream vehicle or human segment.

Velocity is Assigned

If you want to assign the velocity of the human or vehicle at the current path location, check this box and enter the velocity. When unchecked, all velocity fields are disabled. When checked for a vehicle whose total velocity is zero, an initial velocity vector is created for on-screen editing.

Velocity

This group contains the following items:

- **Total** — Total linear velocity of the vehicle or human. The U and V components are computed automatically from the Total velocity and the Sideslip angle.
- **U** — Linear velocity component in the vehicle-fixed or human segment-fixed forward direction. This field is auto-computed from Total, Sideslip and W, but remains editable.
- **V** — Linear velocity component in the vehicle-fixed or human segment-fixed lateral direction. This field is auto-computed from Total, Sideslip and W, but remains editable.
- **W** — Linear velocity component in the vehicle-fixed or human segment-fixed vertical direction.
- **Sideslip** — Angle (deg) between the total velocity vector and the vehicle-fixed (or segment-fixed) x-axis heading. Editing the sideslip angle recomputes the U and V velocity components.
- **Roll** — Angular velocity about the vehicle-fixed X or human segment-fixed X axis. For trailers and human segments other than the pelvis, these are articulation rates relative to the upstream segment.
- **Pitch** — Angular velocity about the vehicle-fixed Y or human segment-fixed Y axis. For trailers and human segments other than the pelvis, these are articulation rates relative to the upstream segment.
- **Yaw** — Angular velocity about the vehicle-fixed Z or human segment-fixed Z axis. For trailers and human segments other than the pelvis, these are articulation rates relative to the upstream segment.

> **Note:** For 2-dimensional calculation methods, the W, Roll rate and Pitch rate fields are disabled.

Apply

Applies the currently displayed position and velocity values to the selected object and updates the object's display in the event editor.

Updated to match the current version of HVE.

Simulation Controls Dialog Box

This dialog displays and allows editing of all simulation control data for the current event. Each value is entered with a slider or by typing directly into the associated edit field.

Integration Timesteps

Integration timesteps define the discrete timestep used by the simulation and are dependent on the purpose and type of the simulation.

- **Human Collisions (sec)** — Integration timestep used during the collision phase for occupant and pedestrian simulations.
- **Vehicle Collisions (sec)** — Integration timestep used during the collision phase for vehicle simulations.
- **Curb Impact (sec)** — Integration timestep used during curb impact for vehicle simulations.
- **Vehicle Separation (sec)** — Integration timestep used during the initial portion of the post-impact phase for vehicle simulations.
- **Vehicle Trajectory (sec)** — Integration timestep used for vehicle trajectory simulations.
- **Output Time Interval (sec)** — Event time output interval.

Termination Conditions

Termination conditions are used to define when the simulation terminates. Termination linear and angular velocities are natural termination conditions which define when a simulated object has stopped moving.

- **Maximum Time (sec)** — Maximum simulation time.
- **Linear Velocity (mph)** — Minimum linear velocity; event termination may result if the current linear velocity is less than this value.
- **Angular Velocity (deg/sec)** — Minimum angular velocity; event termination may result if the current angular velocity is less than this value.
- **Maximum Bisections** — Maximum number of times the integration timestep may be halved.
- **Velocity Convergence** — Allowable error between predicted and actual integration results.
- **Velocity Change Limit** — Maximum allowable change in velocity during one timestep.
- **Acceleration Change Limit** — Maximum allowable change in acceleration during one timestep.

Updated to match the current version of HVE.

Calculation Options

Dialog and feature reference for the HVE **Calculation Options** area, converted from the on-line help. Part of the HVE Manual.

Pages

- Calculation Options for EDCRASH
- Calculation Options for EDGEN
- EDSMAC Calculation Options
- EDSMAC4 Calculation Options
- EDSVS Calculation Options
- EDVDS Calculation Options
- EDVSM Calculation Options
- EDVTS Calculation Options
- Calculation Options for EDHIS

Calculation Options for EDCRASH

EDCRASH (Engineering Dynamics Company Reconstruction of Accident Speeds on the Highway) is an analysis used to reconstruct single and two vehicle accidents. EDCRASH is based on the Calspan Reconstruction of Accident Speeds on the Highway (CRASH) and includes refinements and enhancements provided by the National Highway Traffic Safety Administration (NHTSA) and Engineering Dynamics Company, LLC. The program determines the conditions of impact, including the impact speeds and delta-V of the vehicles, using information obtained from vehicle and accident site inspections.

The output generated by EDCRASH depends on the amount of information supplied. The minimum information required is a description of the vehicle damage. Therefore, when accident site information is not supplied, the resulting output will be limited to an analysis of the severity of impact, including delta-V (speed change) and magnitude and principal direction of force. When accident site information is supplied, the output will also include the speed of the vehicle(s) at impact.

EDCRASH is a useful tool for investigating the circumstances of an accident. These circumstances include the effect of human, vehicle and environmental factors on the pre-impact and post-impact events.

An extremely useful feature of EDCRASH is the ability to quickly and accurately review the results generated from different input scenarios. Termed

what if

analysis, changes can be made to an isolated variable or set of variables and the effects are displayed immediately. Only the parameters that change need to be modified; the HVE Event Editor saves all the previously entered information. For example, the sensitivity of the results to impact positions, rest positions or principal direction of force can be analyzed by merely changing the event and re-executing.

The EDCRASH Calculation Options dialog contains four groups of options — Program Options, Separation Velocity Basis, Consistency Checks and Simulation Convergence Criteria — plus an

Apply Defaults

button that restores all values in the dialog to their factory defaults.

Program Options

Four check boxes enable or disable individual EDCRASH calculation procedures:

- **Common Velocity check** — When checked, EDCRASH tests the computed separation velocities of the two vehicles to be sure they are compatible with the assumption of a common velocity at maximum engagement. Default: checked.
- **Modify Departure Angle** — When checked, EDCRASH tests, and possibly modifies, the departure (separation) angles based on the computed post-impact rotation and rollout velocity. Default: checked.
- **Auto - Set Rot/Lat Skidding** — When checked, EDCRASH automatically determines whether each vehicle experienced rotational/lateral skidding during its post-impact trajectory, rather than relying solely on the user-entered skidding flags. Default: checked.
- **Include Angular Momentum Solution** — When checked, EDCRASH includes a conservation of angular momentum solution in addition to the standard linear momentum solution. Default: unchecked. Note: this check box is disabled (grayed out) in the current version of the dialog and cannot be changed.

Separation Velocity Basis

This group of radio buttons selects the method EDCRASH uses to compute the vehicles' separation velocities. The default is

Normal

.

- **Normal** — Choosing *Normal* causes EDCRASH to perform its standard, energy-based calculations to provide an estimate for separation forward, lateral and angular velocities and departure angle.
- **Trajectory Simulation** — Choosing *Trajectory Simulation* causes EDCRASH to perform its standard, energy-based calculations (same as choosing *Normal*), and then use the separation velocities and departure angles as the initial conditions for a trajectory simulation. The simulation is run iteratively until the simulated trajectory matches the evidence at rest (and, if entered, end-of-rotation and point-on-curve positions) within the tolerances entered in the *Simulation Convergence Criteria* group below, or until the specified number of runs is reached. Note: this choice does not support vehicles with dual tires; a dual tire at any wheel position is rejected with a fatal error at event initialization.
- **Sustained Contact** — Choosing *Sustained Contact* causes EDCRASH to use a weighted drag factor based on the wheel lock-ups and weights of the individual vehicles.
- **Iterate on Sideslip** — Choosing *Iterate on Sideslip* requests an iterative solution on vehicle sideslip angle. Note: this option is not supported by the current EDCRASH physics engine; selecting it causes the event to terminate with an error.

Consistency Checks

EDCRASH performs several tests that compare independently computed results and issues warning messages when they disagree by more than a user-specified tolerance. The tolerances are:

- **PDOF Range, +/- (deg)** — Warning range for compatibility of the principal directions of force of the two vehicles. Default: 10 degrees.
- **Delta-V Range, +/- (%/100)** — Warning range for compatibility between the damage-based and momentum-based delta-V results. Default: 0.10.
- **K.E. Range, +/- (%/100)** — Warning range for the kinetic energy compatibility test. Default: 0.50.
- **Newton's 3rd Law Range, +/- (%/100)** — Warning range for the test comparing the collision force magnitudes on the two vehicles, which should be equal and opposite per Newton's third law. Default: 1.00.

Simulation Convergence Criteria

These entries apply only when the Separation Velocity Basis is set to

Trajectory Simulation

; they are disabled for the other choices. They control the iteration used to match the simulated post-impact trajectory to the physical evidence:

- **Number Of Runs** — Maximum number of trajectory simulation iterations per vehicle. Default: 5.
- **Rest Error, X-Y (%/100)** — Allowable error in the simulated rest position. Default: 0.10.
- **Rest Error, Heading (%/100)** — Allowable error in the simulated heading angle at rest. Default: 0.10.

- **EOR Error, X-Y (%/100)** — Allowable error in the simulated end-of-rotation position. Default: 0.15.
- **EOR Error, Heading (%/100)** — Allowable error in the simulated heading angle at end of rotation. Default: 0.15.
- **POC Error, X-Y (%/100)** — Allowable error in the simulated position at the user-entered point on curve. Default: 0.15.

Apply Defaults

Pressing the

Apply Defaults

button restores every option in the dialog to its factory default value (the defaults listed above).

Updated to match the current version of HVE.

Calculation Options for EDGEN

EDGEN (**E**ngineering **D**ynamics Company **GEN**eral Analysis Tool) is a 3-dimensional kinematics spreadsheet developed by Engineering Dynamics Company, LLC. EDGEN uses positions and velocities supplied at up to eight user-specified locations (e.g., *Initial, Pre-braking, Impact,* etc.) to determine the time required to travel between each location, and then calculates the current velocity and position at each time step between the user-entered positions.

EDGEN has several applications. For example:

- Time vs. distance studies involving a human or vehicle
- Move a human or vehicle between two or more known positions
- A *reality check* to confirm that data used in key frame animations are reasonable.

As a kinematics model, forces acting on the human or vehicle are not computed.

It is up to the user of EDGEN to review the resulting accelerations and decide if they are reasonable.

When used for a human, EDGEN calculates the motion of the pelvis. Six degrees of freedom (X,Y,Z linear motion, and roll, pitch and yaw angular motion of the pelvis) are calculated. Joint articulations are not included. Therefore, arm and leg motion cannot be simulated.

When used for a vehicle, EDGEN calculates the motion of the sprung mass. Again, six degrees of freedom (X,Y,Z linear motion, and roll, pitch and yaw angular motion) are calculated. Suspension deflection and tire spin degrees of freedom are not included.

The resulting motion is recorded as EDGEN human or vehicle output tracks; the motion is visualized in the 3-D HVE visualization environment.

Path Model

This radio button group selects how EDGEN interpolates the path between the user-entered positions. The default is *Linear Interpolation*.

- **Linear Interpolation** — EDGEN interpolates position and velocity along straight-line segments between successive user-entered positions.
- **3-D Spline Interpolation** — EDGEN fits a 3-D spline through the user-entered positions and interpolates position and velocity along the resulting smooth, curved path.

Updated to match the current version of HVE.

EDSMAC Calculation Options

EDSMAC (Engineering Dynamics Company Simulation Model of Automobile Collisions) is a simulation analysis of two-vehicle crashes, based on the SMAC program developed at Calspan for NHTSA. The Calculation Options dialog for an EDSMAC event exposes the collision-phase solution parameters described below. Each parameter is stored with the event and read by the physics engine when the event is executed.

The collision algorithm models each vehicle's periphery as a set of radial RHO vectors extending outward from the CG. During vehicle-to-vehicle contact the collision routine iteratively shortens the overlapping RHO vectors until the collision pressures acting between the two vehicles are in equilibrium; the shortened vectors define the crush profile.

Vector Spacing (deg)

Default: 2.0 degrees. Range: 1.0 to 5.0 degrees.

This angle determines the angular interval between the RHO vectors that define each vehicle's crush perimeter. Smaller values give a finer damage profile at the cost of computation time (the number of RHO vectors per vehicle is 360°/spacing — 181 vectors at the 2-degree default).

Vector Adjustment Increment (in)

Default: 0.20 in. Range: 0.01 to 0.5 in.

This increment determines the incremental adjustment applied to each RHO vector as the collision routine seeks to establish force equilibrium between the vehicles.

Vector Force Tolerance (lb/in)

Default: 15.0 lb/in. Range: 5.0 to 50.0 lb/in.

The allowable difference in the collision pressure (force per unit width) computed along corresponding RHO vectors for each vehicle. A small value is preferable; in general it should not exceed 50 lb/in (about 100 N/cm). (In the current release this control is labeled

Max Pressure Error

in the dialog.)

Inter-Vehicle Friction

Default: 0.55. Range: 0.05 to 2.0 (dimensionless).

The coefficient of sliding friction between the vehicle exteriors, used to compute the tangential (friction) component of the collision force.

Note: the original on-line help interchanged the descriptions of this option and *Min Velocity for Friction*, below. The descriptions given here are correct: this field is the inter-vehicle friction coefficient, and the field below is the minimum velocity at which that friction is fully developed.

Min Velocity for Friction (in/sec)

Default: 5.0 in/sec. Slider range: 5.0 to 50.0 in/sec (values from 0.1 to 100 in/sec may be typed).

The minimum relative tangential surface velocity at which the full inter-vehicle friction is achieved. Below this velocity the friction force is scaled linearly with the relative sliding velocity, so the effective friction coefficient becomes $\mu\,(v_t\ /\ v_{min})$, where μ is the Inter-Vehicle Friction value, v_t the relative tangential velocity and v_{min} this minimum velocity. This prevents numerical chatter as the contact velocity approaches zero.

Restitution Constant

Default: 0.04606. Range: 0.0 to 1.0.

The constant term of the parametric restitution model used by EDSMAC during the unloading (restitution) phase of the collision. The effective restitution applied to each damaged RHO vector is computed from that vector's change in length (crush depth) δ:

> $e(\delta) = c0 - c1\cdot\delta + c2\cdot\delta^2$

Restitution is applied only while δ is less than c1/(2·c2) (the vertex of the parabola); each damaged vector is allowed to "rebound" toward its undamaged length in proportion to e.

Restitution Linear Coef (1/in)

Default: 0.0017547 1/in. Range: 0.0 to 0.1 1/in.

The linear (crush-depth proportional) term of the parametric restitution model.

Restitution Quadratic Coef (1/in^2)

Default: 0.000016711 1/in². Range: 0.0 to 50.0 1/in².

The quadratic term of the parametric restitution model.

Terrain Search Options (moved to the Get Surface Information dialog)

The old help listed *From First Polygon*, *From Previous Polygon* and *By Elevation* as EDSMAC calculation options, with no descriptions. These terrain-database search options are no longer part of the EDSMAC Calculation Options dialog: they are now set in the separate **Get Surface Information Options** dialog (Options menu), which applies to any simulation event. The **Method**, **Direction** and z-component settings made there are stored with each event. Case files older than version 63 automatically migrate their old EDSMAC terrain-search setting into the new dialog.

These options control how HVE searches the terrain polygon (triangle) database for the surface elevation, normal, friction and water depth beneath each tire at every timestep.

Method (default: From Previous Polygon, Sorted):

- **From First Polygon** — Every query searches the whole database in list order from the first polygon and uses the first polygon containing the search point. Simple, but slowest on large terrains.

- **From Previous Polygon** — Water polygons are checked first, then the search starts at the polygon found on the previous call and spreads outward (forward and backward) through the database, returning on the first hit. Fast on contiguous terrain meshes, but friction-zone precedence is not enforced.
- **From Previous Polygon, Sorted** (default) — Water, curb and friction-zone polygons are always checked first, so friction zones painted over a road surface correctly take precedence over the underlying road polygons; the remaining road polygons are then searched spreading outward from the previous polygon.
- **By Elevation** — Intended to search the entire database and keep the highest surface beneath the wheel center (for overlapping surfaces such as bridge decks). **Not currently implemented:** the radio button is disabled in the dialog, and if the option is ever selected EDSMAC reports a fatal error at execution and the event will not run.

Direction (default: Upward Facing Only) — controls which terrain triangles are admitted to the physics terrain database when the environment geometry is compiled:

- **All Directions** — All road/friction-zone/water triangles are usable regardless of the direction of their surface normal.
- **Upward Facing Only** (default) — Only triangles whose surface normal has an upward component are used. Curb polygons are exempt from the normal test.
- **Z Component, Greater Than** — Only triangles whose unit surface normal has a z-component greater than the user-entered value (allowed range −1.0 to 1.0, default 0.0) are used; the edit field is enabled only for this choice.

Updated to match the current version of HVE.

EDSMAC4 Calculation Options

EDSMAC4 (Engineering Dynamics Company Simulation Model of Automobile Collisions, 4th Revision) is a simulation analysis of single or multiple-vehicle crashes. It is based on the program called SMAC developed at Calspan for NHTSA, and includes several major extensions and enhancements developed by Engineering Dynamics Company, LLC. EDSMAC4 uses a set of assumed or estimated initial conditions, including positions, velocities and driver controls, provided by the user for each vehicle. EDSMAC4 then predicts the outcome of a crash by simulating the vehicle trajectories and damage profiles.

The output generated by EDSMAC4 is a time history of the vehicle kinematics (position, velocity and acceleration), kinetics (summation of tire and collision forces and moments acting at the CG), and tire skidmarks for the duration of the crash sequence. The program also computes the resulting damage profiles, the Collision Deformation Classifications (CDC), Principal Direction of Force (PDOF), delta-V (a measure of crash severity) and peak acceleration for each damage range. EDSMAC4 also produces a collision pulse (acceleration vs time history) useful for occupant simulations, such as EDHIS.

Accident investigators can use EDSMAC4 to determine how the crash may have occurred. By repeated adjustments of the initial conditions and driver braking (or acceleration) and steering inputs, the user will converge on the data that best match the known accident site evidence (usually rest positions, skidmarks and vehicle damage).

In addition to vehicle-to-vehicle collisions, EDSMAC4 may also be used for many types of barrier collisions, including pole impacts.

Users of EDCRASH will find it convenient to first analyze the accident using EDCRASH to estimate the impact speeds, then use these speeds as the initial conditions for the EDSMAC4 program. The resulting confirming analysis is very powerful.

Accident researchers can use EDSMAC4 to simulate an actual staged collision test. This can be done

before

the test in order to predict or anticipate the result and help during test preparations. Test parameters may be adjusted based on EDSMAC4 results to help ensure the test is successful. After the test, the researcher can note the differences between the actual and simulated collision and modify the EDSMAC4 input in order to obtain a better match.

An extremely useful feature of EDSMAC4 is the ability to quickly and easily review the results associated with different input scenarios. Termed

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analysis, changes can be made to an isolated variable or set of variables in order to identify their effect on the outcome. Only the inputs that change need to be modified; the program saves all the previously entered information. For example, the sensitivity of the result to initial velocity, or post-impact driver control, can be studied by merely changing those parameters.

Another useful feature of the program is the ability to display the results in 3-D viewers. These trajectory simulators display the vehicles at user-specified time intervals during the sequence. Using HVE's video interface, it is simple and easy to route the trajectory simulation to video tape.

EDSMAC4 has the following parameter options, listed in dialog order. Each is stored with the event and read by the physics engine when the event is executed.

Vector Spacing (deg)

Default: 2.0 degrees.

This angle determines the angular interval between the RHO vectors that define each vehicle's crush perimeter. (The old help recommended a value of 1 degree; the current program default is 2 degrees.)

Vector Adjustment Increment (in)

Default: 0.20 in.

This increment determines the incremental adjustment for each RHO vector as the collision routine seeks to establish force equilibrium between vehicles.

Vector Force Tolerance (lb/in)

Default: 15.0 lb/in.

This value is the allowable difference in the force computed along corresponding RHO vectors for each vehicle. A small value is obviously preferable. In general, it should not exceed 50 lb/in (about 100 N/cm).

Min Velocity for Friction (in/sec)

Default: 5.0 in/sec.

The minimum relative tangential surface velocity at which the full inter-vehicle friction is achieved. Below this velocity the friction force scales linearly with sliding velocity: the effective friction coefficient becomes $\mu\,(v_t\,/\,v_{min})$, where μ is the Inter-Vehicle Friction value, v_t the relative tangential velocity and v_{min} this minimum velocity.

Note:

the old on-line help interchanged the descriptions of this option and inter-vehicle friction. The description given here is correct: this field is the minimum velocity, not the friction coefficient.

Restitution Constant

Default: 0.04606.

This value is the constant term used for the parametric restitution model used in EDSMAC4.

Restitution Linear Coef (1/in)

Default: 0.0017547 1/in.

This value is the linear term used for the parametric restitution model used in EDSMAC4.

Restitution Quadratic Coef (1/in^2)

Default: 0.000016711 1/in².

This value is the quadratic term used for the parametric restitution model used in EDSMAC4.

Inter-Vehicle Friction (removed from this dialog)

The Inter-Vehicle Friction coefficient (default 0.55) is **no longer set in the EDSMAC4 Calculation Options dialog**. It is now assigned per vehicle pair in the Vehicle Mesh dialog (Inter-Vehicle Options group), and the physics engine takes the collision friction coefficient from that setting.

Use Vehicle Geometry for Rho Vector Init

Default: unchecked (off).

When checked, the initial lengths of the RHO (crush perimeter) vectors are computed from the vehicle's actual body mesh geometry rather than from the idealized rectangular vehicle outline. This improves collision detection and damage profiles for vehicles whose plan-view shape departs significantly from a rectangle.

Steer DOF

Default: Off. Choices:

- **Off** (default) — The steer degree of freedom is not simulated; wheel steer angles follow the driver steer tables directly.
- **Normal** — The dynamic steer degree of freedom is active for the entire event; steer angles are computed from the torques acting on the steering system (wheel friction, steering stops, gyroscopic precession, column friction) and the driver steer tables are ignored.
- **Append** — The steer tables are followed to their end; the final table entry then becomes the initial condition for the steer degree of freedom, which controls the steering for the remainder of the run.
- **AutoStart** — The steer tables are followed until the first collision contact; at impact the steer degree of freedom starts automatically with the current steer angle and zero steer velocity. Useful for modeling a driver's loss of steering control at impact.

Inter-Vehicle Connection

Default: Adjust Both Equally. When a tow vehicle and trailer are connected, the heights of their user-entered hitch points may not match. If the height mismatch exceeds 0.1 in, this option selects how the gap is closed at event initialization — by adjusting the connection points' z-coordinates on the vehicles, not by moving the vehicles themselves:

- **Manual (User-Adjusted)** — No automatic adjustment; the user must enter connection heights that match.
- **Adjust Tow Vehicle** — The tow vehicle's rear connection height is adjusted to meet the trailer's.
- **Adjust Trailer** — The trailer's front connection height is adjusted to meet the tow vehicle's.
- **Adjust Both Equally** (default) — Each connection height is adjusted by half of the mismatch.

Connection Model

Default: Use Heavier Vehicle. Selects how the connection (hitch) constraint stiffness and damping are derived when computing the forces between connected vehicles:

- **Use Both Vehicles** — Spring rate and damping are derived from the *lighter* of the two vehicles' weights.
- **Use Heavier Vehicle** (default) — Spring rate and damping are derived from the heavier vehicle's weight.
- **Use Tow Veh Properties** — The tow vehicle's user-entered hitch stiffness and damping values are used directly.

Hydroplane Model

Default: Off. Choices:

- **Off** (default) — No hydroplaning effects.
- **NASA** — The NASA (Horne/Borne) hydroplaning model is applied at each tire travelling over a water polygon. The model predicts the hydroplaning (spin-down) speed from the tire's inflation pressure alone: a tire hydroplanes when its forward ground-plane speed exceeds $182.16\sqrt{P}$ in/sec, with P in lb/in² (equivalently $10.35\sqrt{P}$ mph). Above that speed the tire's friction multiplier switches from the surface friction to the friction assigned to the water polygon, sharply reducing the available longitudinal and lateral tire forces.

The friction multiplier is applied to both the peak and sliding friction coefficients taken from the tire's friction tables, so hydroplaning reduces the tire force available longitudinally

and

laterally — braking, drive traction and cornering capability are all lost together.

> **NOTE:** The friction reduction described above is the whole of the model's effect. The extra drag of displacing water is not modeled.

(HVE also provides NASA-TTI and Gallaway hydroplaning models — both offered by SIMON, see SIMON — Hydroplaning Model — and a Blythe-Day model that is not implemented in any program. Only Off and NASA appear in the EDSMAC4 dialog; any other selection is rejected with a fatal error and the event will not run.)

Accident History Basis

Default: Impact Force. Selects the criterion used to detect the beginning and end of each collision phase reported in the Accident History (damage ranges, delta-V, peak acceleration):

- **Impact Force** (default) — A collision phase is bounded by the presence of inter-vehicle collision force. Impact is declared on the first timestep on which collision force acts; separation is declared one timestep after it ceases.
- **Acceleration** — A collision phase is bounded by the vehicle's total acceleration exceeding the **Threshold (g)** value. The threshold edit field (default 1 g, initialized from the environment's gravity) is enabled only when this basis is selected. Impact is declared when either vehicle's total acceleration exceeds the threshold; separation is declared after both vehicles have remained below it for six consecutive timesteps.

In both cases the vehicles' perimeters must also overlap before impact can be declared — the acceleration test is an additional condition, not a substitute for contact.

> **NOTE:** The acceleration used by the Acceleration basis is the vehicle's *total* acceleration, which includes tire forces. A threshold low enough that hard braking or cornering exceeds it on its own can prevent separation from ever being declared, leaving the event in the collision phase — and at the collision timestep — for the remainder of the run.
>
> **NOTE:** The Threshold value is used by the Traditional Damage Data Format regardless of which basis is selected. Although the field is disabled when the basis is Impact Force, the stored value (1 g by default) still sets the minimum acceleration at which an acceleration peak is recognized and delta-V accumulated in that report.

See EDSMAC4 — Impact and Separation Times for the full description.

Damage Data Format

Default: Collision Data. Choices:

- **Traditional** — Damage is reported in the traditional EDSMAC-style damage-profile format: damage ranges along the crush perimeter, each with a CDC, PDOF, total delta-V, time of peak acceleration and peak acceleration. The severity figures are derived from peaks in the vehicle's acceleration history.
- **Collision Data** (default) — Damage is reported using HVE's extended Collision Data format: one row per collision pulse, with the vehicle struck, the pulse start and end times and duration, peak acceleration, peak collision force, delta-V and PDOF, followed by separate damage-profile and crush tables. The severity figures are derived from the inter-vehicle collision force and the accumulated velocity change.

This option selects the calculation as well as the layout. The two methods are independent and will not give identical PDOF, delta-V or peak acceleration values; see EDSMAC4 — Collision Severity Results. The Traditional format is retained for comparison with results from earlier releases, and is only available for events with more than one vehicle.

- **Include Free Space** — When checked, the reported crush measurements include free-space (induced) deformation in addition to direct-contact crush. In the current release this checkbox is permanently checked and disabled; free space is always included.

Terrain Search Options (Get Surface Information)

The old help ended with three undocumented entries — *From First Polygon*, *From Previous Polygon* and *By Elevation*. These options select how HVE searches the terrain polygon (triangle) database beneath each tire at every timestep. They are no longer part of the EDSMAC4 Calculation Options dialog; they are set in the separate **Get Surface Information Options** dialog (Options menu), and the Search Method, Search Direction and z-component settings made there are stored with each event. The behavior is:

Search Method (default: From Previous Polygon, Sorted):

- **From First Polygon** — The entire terrain database is searched in order starting from the first polygon; the first polygon containing the search point is used. Simple but slowest for large terrains.
- **From Previous Polygon** — The search starts at the polygon found on the previous timestep and spreads outward (forward and backward) through the database, returning on the first hit. Fast, but friction-zone precedence is not enforced (water polygons are still checked first).

- **From Previous Polygon, Sorted** (default) — Water, curb and friction-zone polygons are checked first (so friction zones take precedence over the underlying road surface), then the search proceeds from the previous polygon, spreading outward. This is the recommended method.
- **By Elevation** — Intended to search the entire database and return the polygon with the highest elevation beneath the wheel center (for overlapping surfaces such as bridges). **Not currently implemented:** the radio button is disabled in the dialog, and if the option is ever selected the physics engines report a fatal error and the event will not run.

Search Direction (default: Upward Facing Only) — Controls which terrain triangles are considered usable when the terrain database is built:

- **All Directions** — All triangles are used regardless of the direction of their surface normal.
- **Upward Facing Only** (default) — Only triangles whose surface normal has an upward component are used (downward-facing and vertical triangles are discarded). Curb polygons are exempt from the normal test.
- **Z Component, Greater Than** — Only triangles whose unit surface normal has a z-component greater than the user-entered value (default 0.0) are used. The edit field is enabled only for this choice.

DyMESH

EDSMAC4 does not use the DyMESH 3-D collision algorithm; the DyMESH Options dialog applies to SIMON events only.

Updated to match the current version of HVE.

EDSVS Calculation Options

EDSVS (Engineering Dynamics Company Single Vehicle Simulator) is a simulation analysis of the response of a motor vehicle (4-wheeled automobile, or truck having a tandem axle and dual tires) to driver inputs (accelerating, braking and steering). It is based on a program called TBST developed at the University of Michigan Transportation Research Institute. EDSVS determines how the vehicle responds to the inputs by generating the path, velocity, acceleration, tire force and other data as a function of time.

Accident investigators can use EDSVS to determine how a driver may have lost vehicular control. By repeated adjustments of the throttle, braking and steering input tables, the user will converge on those driver inputs which match accident site evidence. EDSVS can also be used to study the handling effects due to changes in vehicle weight distribution, wheelbase, track width, CG height, tire friction, cornering stiffness and other parameters.

An extremely useful feature of EDSVS is the ability to quickly and accurately review the results generated from different input scenarios. Termed

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analysis, changes can be made to an isolated variable or set of variables and the effects are displayed immediately. For example, the sensitivity of the trajectory to various front/rear tire combinations can be studied simply by changing the tire data; the sensitivity to CG location can be studied by moving its position. However, the major purpose of EDSVS can be realized by changing the driver input tables (throttle, braking and steering) until the resulting trajectory matches the actual trajectory produced by the vehicle during a particular maneuver. Thus, the user learns how a driver's inputs may have affected the outcome of an accident.

The EDSVS engine does not present or use a Calculation Options dialog, and it reads no calculation-option values from the event. The one parameter historically exposed here — Roll Couple Distribution — is now taken from the vehicle's suspension data instead.

Roll Couple Distribution

Roll Couple Distribution sets the fraction of the total lateral load transfer (roll couple) that is reacted by the front axle; the remainder is reacted by the rear axle. It is expressed as a fraction (units %/100) in the range 0.00 to 1.00. The default value is 0.55 (55 percent of the roll couple carried by the front axle).

For EDSVS this value is **not** entered through a Calculation Options dialog. It is set on the vehicle editor's suspension screen, as the vehicle's **Roll Couple Distribution** suspension setting, and read from there by the physics engine.

Within the physics model, this parameter is the front-axle lateral load transfer coefficient γ_1, with the rear axle taking $\gamma_2 = 1 - \gamma_1$, which apportion the lateral weight shift used to compute the individual tire normal loads during cornering.

Note: An event still carries a legacy calculation-options value for this parameter (default 0.55), but the current EDSVS engine does not read it. The roll couple distribution used by the simulation always follows the vehicle editor's suspension setting.

Removed Options

Earlier versions of this help topic listed the terrain surface-search choices **From First Polygon**, **From Previous Polygon** and **By Elevation** as EDSVS calculation options. These are no longer part of the EDSVS Calculation Options dialog.

The surface-search method is now selected in the separate Get Surface Information Options dialog (Options menu), which offers From First Polygon, From Previous Polygon, From Previous Polygon (Sorted) and By Elevation.

Updated to match the current version of HVE.

EDVDS Calculation Options

EDVDS (Engineering Dynamics Company Vehicle Dynamics Simulator) is a simulation of the dynamic response of a vehicle towing up to three trailers. It is based on a program called Phase 4 developed at the University of Michigan Transportation Research Institute. EDVDS simulates the vehicle's response to driver inputs (accelerating, braking and steering). EDVDS determines how the vehicle responds to these inputs by generating the vehicle path, velocity, acceleration, tire forces, and other data as a function of time.

EDVDS includes several extensions to the original Phase 4 program. These extensions, developed by Engineering Dynamics Company, LLC, include a full 3-D simulation capability, an updated suspension model with jounce and rebound stops, an updated semi-empirical tire model that supports a full 360-degree range of slip angles and a 2-step radial tire stiffness, and the ability of each tire to respond to an arbitrary 3-D terrain.

Vehicle design engineers can use EDVDS to assess how various changes to suspension and tire parameters affect vehicle handling behavior. After setting up a series of simulation experiments, such as step-steer or J-turn maneuvers, alternate ramp traversals or a timed series of brake application pressures, engineers can vary the vehicle design parameters of interest and quickly determine their effect.

Accident investigators can use EDVDS to determine how a driver may have lost vehicular control. By repeated adjustments of the throttle, braking and steering input tables, the researcher will converge on those driver inputs which match accident site evidence. Thus, the user learns how a driver's input may have affected the cause and/or outcome of an accident.

EDVDS employs full 3-D engineering models with up to 23 degrees of freedom for each vehicle. The program supports up to 4 axles per vehicle, solid axle suspension types with inter-tandem load transfer, and single and dual tires. Combination vehicles are connected using fixed and converter dollies with rigid or hinged drawbars. EDVDS also employs a comprehensive drivetrain model with engine performance parameters and multi-gear transmissions and differentials.

Tire vs terrain contact is modeled transparently to the user. At each simulation timestep, the EDVDS tire model queries the terrain's physical characteristics (elevation, slope and friction) beneath each tire. The EDVDS tire model then uses this information to determine current tire forces at each tire.

EDVDS has the following user-selectable calculation option:

Tire Model Method

This radio group selects the method used to compute tire forces. The choices are:

- **Linear** (the default) — Tire shear forces are computed using the linear tire model, in which lateral and longitudinal forces are derived from the tire's cornering stiffness and longitudinal stiffness.
- **Semi-Empirical** — Tire shear forces are computed using the EDC-extended semi-empirical tire model. This model supports a full 360-degree range of slip angles and a 2-step radial tire stiffness, and is generally preferred for severe maneuvers involving large slip angles.
- **Table Look-Up** — *Not currently available.* This choice is greyed out in the dialog; if it is ever selected the physics engine reports a fatal error and the event will not run.

Removed Options

Earlier versions of this help topic listed the terrain surface-search choices **From First Polygon**, **From Previous Polygon** and **By Elevation** as EDVDS calculation options. These are no longer part of the EDVDS Calculation Options dialog. The surface-search method is now selected in the separate Get Surface Information Options dialog (Options menu). Note that EDVDS does not support the By Elevation method; choosing it for an EDVDS event produces an error message when the event is executed.

Updated to match the current version of HVE.

EDVSM Calculation Options

EDVSM (Engineering Dynamics Company Vehicle Simulation Model) is a 3-D analysis of the response of a unit vehicle to a driver's inputs (steering, throttle, brakes, gear selection). EDVSM is based on the HVOSM model developed at Calspan. The original HVOSM model was developed in two versions: The Roadside Design version (RD2) was developed for studying vehicle interactions with the roadside environment, while the Vehicle Dynamics version (VD2) was developed for studying vehicle response to driver inputs. EDVSM was derived from the VD2 version of HVOSM, and includes several extensions and refinements provided by Engineering Dynamics Company, LLC.

EDVSM computes vehicle kinematics (position, velocity and acceleration vs time) from forces defined at the tire-road interface, as well as from aerodynamics. EDVSM is useful for predicting and visualizing a vehicle's response to driver's inputs, as well as for studying the effects of various design parameters on vehicle behavior.

The EDVSM vehicle model is

fully

three-dimensional. It includes six degrees of freedom for the sprung mass. It also includes degrees of freedom for both independent and solid axle suspension types. A wheel spin degree of freedom is also included for each wheel, and a steer degree of freedom exists for the steering system.

EDVSM includes detailed models of braking systems to allow the study of vehicle brake system characteristics on vehicle behavior during severe driving maneuvers, such as that which might occur during accident avoidance. EDVSM also has a detailed drivetrain model that includes an engine, transmission and differential. The drivetrain model may be used for detailed studies of a vehicle's response to throttle inputs and gear selection.

EDVSM has the following user-selectable calculation options:

Tire Model Method

This radio group selects the method used to model the tire-terrain interaction. The choices are:

- **Normal** (the default) — Tire forces are computed at the tire-road contact patch using the standard EDVSM point-contact tire model.
- **Radial Spring** — *Not currently available.* Intended for modeling tire traversal of sharp-edged terrain irregularities using radial springs distributed around the tire circumference. This choice is greyed out in the dialog; the physics engine accepts only Normal and reports a fatal error for any other selection.
- **Sidewall Impact** — *Not currently available.* Intended for modeling forces produced by contact between the tire sidewall and a curb-like obstacle. This choice is greyed out in the dialog and rejected by the physics engine.

Steer DOF

This radio group controls the steering system's steer degree of freedom. The choices are:

- **Off** (the default) — The steer degree of freedom is not integrated; the front wheel steer angles follow the driver's steer input tables directly.
- **Normal** — The steer degree of freedom is active. The front wheel steer angle is computed dynamically from the moments acting about the steer axis (tire forces, gyroscopic moments, steering system stiffness and damping), so the simulated steering response includes steering system compliance effects.

- **Append** — *Not currently available.* This choice is greyed out in the dialog; if it is ever selected the physics engine reports a fatal error and the event will not run.

Vehicle Body vs Environment Contact

The default is off (unchecked).

When checked, EDVSM performs body-to-terrain contact calculations using the HVOSM hardpoint model extended by EDC to use the vehicle's 3-D body mesh: when the vehicle's roll or pitch angle exceeds a threshold (5 degrees), each body mesh vertex is tested against the terrain, and contact forces and moments (including friction) are applied to the sprung mass. Vertex deformations are accumulated, allowing a damage profile to be computed and visualized; Damage Profiles output is available in Playback mode only when this option is checked. Enabling this option also removes the wheel camber inclination limit that otherwise prevents rollover, so this option must be checked for rollover simulations.

When unchecked, body-terrain contact forces are not computed, and the simulation is limited to maneuvers in which only the tires contact the terrain.

Removed Options

Earlier versions of this help topic listed the terrain surface-search choices **From First Polygon**, **From Previous Polygon** and **By Elevation** as EDVSM calculation options. These are no longer part of the EDVSM Calculation Options dialog. The surface-search method is now selected in the separate Get Surface Information Options dialog (Options menu). Note that EDVSM does not support the By Elevation method; choosing it for an EDVSM event produces an error message when the event is executed.

Updated to match the current version of HVE.

EDVTS Calculation Options

EDVTS (Engineering Dynamics Company Vehicle Trailer Simulator) is a simulation analysis of the response of an articulated vehicle (either a passenger car pulling a standard trailer, or a commercial tractor-trailer vehicle) to driver inputs (accelerating, braking and steering). It is based on a program called TBSTT developed at the University of Michigan Transportation Research Institute. EDVTS determines how the vehicle responds to the inputs by generating the path, velocity, acceleration, tire force, and other data as a function of time.

Accident investigators can use EDVTS to determine how a driver may have lost vehicular control. By repeated adjustments of the throttle, braking and steering input tables, the user will converge on those driver inputs which match accident site evidence. EDVTS can also be used to study the handling effects due to changes in vehicle weight distribution, wheelbase, track width, CG height, tire friction, cornering stiffness, hitch or kingpin location and other parameters.

An extremely useful feature of EDVTS is the ability to quickly and accurately review the results generated from different input scenarios. Termed

what if

analysis, changes can be made to an isolated variable or set of variables and the effects are displayed immediately. For example, the sensitivity of the trajectory to various front/rear tire combinations can be studied simply by changing the tire data; the sensitivity to CG location can be studied by moving its position. However, the major purpose of EDVTS can be realized by changing the driver input tables (throttle, braking and steering) until the resulting trajectory matches the actual trajectory produced by the vehicle during a particular maneuver. Thus, the user learns how a driver's inputs may have affected the outcome of an accident.

The EDVTS engine does not present or use a Calculation Options dialog, and it reads no calculation-option values from the event. The one parameter historically exposed here — Roll Couple Distribution — is now taken from the tow vehicle's suspension data instead.

Roll Couple Distribution

Roll Couple Distribution sets the fraction of the tow vehicle's total lateral load transfer (roll couple) that is reacted by the front axle; the remainder is reacted by the rear axle. It is expressed as a fraction (units %/100) in the range 0.00 to 1.00. The default value is 0.55 (55 percent of the roll couple carried by the front axle).

For EDVTS this value is **not** entered through a Calculation Options dialog. It is set on the vehicle editor's suspension screen, as the tow vehicle's **Roll Couple Distribution** suspension setting, and read from there by the physics engine; the former calculation-options entry is no longer used.

Within the physics model, this parameter is the front-axle lateral load transfer coefficient γ_1, with the rear axle taking $\gamma_2 = 1 - \gamma_1$ for the tow vehicle, which apportion the lateral weight shift used to compute the individual tire normal loads during cornering.

Note: An event still carries a legacy calculation-options value for this parameter (default 0.55), but the current EDVTS engine does not read it. The roll couple distribution used by the simulation always follows the vehicle editor's suspension setting.

Removed Options

Earlier versions of this help topic listed the terrain surface-search choices **From First Polygon**, **From Previous Polygon** and **By Elevation** as EDVTS calculation options. These are no longer part of the EDVTS Calculation Options dialog. The surface-search method is now selected in the separate Get Surface Information Options dialog (Options menu), which offers From First Polygon, From Previous Polygon, From Previous Polygon (Sorted) and By Elevation.

Updated to match the current version of HVE.

Calculation Options for EDHIS

EDHIS (Engineering Dynamics Company Human Impact Simulator) is a 3-D analysis of the response of a human occupant or pedestrian during a motor vehicle collision. EDHIS is based on the HSRI-3D model developed at the University of Michigan Transportation Research Institute, and includes several extensions and refinements produced by Engineering Dynamics Company, LLC. The model was developed as a tool to study advanced safety concepts and designs of seat restraint systems from the viewpoint of occupant protection. EDHIS employs airbag and belt (torso and lap) models useful for studying issues related to restraint system effectiveness. EDHIS is useful for predicting and visualizing occupant and pedestrian motion during impact. The model also provides important injury predictions, including HIC, Chest SI and Maximum Femur Load.

EDHIS computes human kinematics (position, velocity and acceleration vs. time), joint angles and torques, and contact force between the human and vehicle.

The EDHIS human model includes 12 degrees of freedom. The human is represented by three inertial segments (head, torso and lower extremities) and 2 joints (neck and hip). The body is visualized using the HVE 15-segment, 14-joint model by combining the head and neck into a single segment called the head; the HVE pelvis, abdomen and chest are combined to form the EDHIS torso; and the right and left upper legs, lower legs and feet are combined to form the lower extremities. 3-D ellipsoids may be attached to any of these three segments to sense force-producing interactions with the vehicle interior or exterior.

The motion of the vehicle is defined by a 6 degrees-of-freedom collision pulse (acceleration vs. time history). The vehicle has attached to it a number of planar contact surfaces that may be arranged to form interior surfaces, such as seats, dashboards and windshields, and exterior surfaces, such as bumper, grill, hood and windshield. Forces are applied to the human whenever interaction is sensed between the human ellipsoids and the vehicle contact surfaces.

The motion and forces resulting from human vs. vehicle interactions are recorded as EDHIS output tracks; the resulting motion is also visualized in the 3-D HVE visualization environment.

The EDHIS Calculation Options dialog controls the numerical integration method and two numerical thresholds, described below.

Numerical Integration Method: Start

This radio button group selects the method used to start the numerical integration, i.e., to generate the solution history points required before the predictor-corrector method can take over. The default is

Modified Runge-Kutta

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- **Euler** — Simple first-order Euler integration.
- **Modified Runge-Kutta** — Runge-Kutta-Ralston integration. This is the default.
- **Runge-Kutta** — Classical Runge-Kutta integration.

Numerical Integration Method: Predictor-Corrector

This radio button group selects the predictor-corrector method used for the main integration once enough starting points are available. The default is

Milne-Hamming

.

- **Adams-Moulton** — Adams-Moulton predictor-corrector.
- **Milne-Hamming** — Milne-Hamming predictor-corrector. This is the default.

Minimum Acceleration

Slider/edit entry for the minimum acceleration threshold. Segment acceleration components whose magnitude is at or below this threshold are set to zero, suppressing numerical noise in the solution. The test is performed only when the value is greater than zero. Default: 0.0000001 (1.0e-7).

Minimum Time Criterion (sec)

Slider/edit entry for the minimum time precision (time epsilon) used by the integration and output control logic, e.g., when deciding whether the current simulation time has reached the next print time. If entered as 0.0 (the default), EDHIS computes the value automatically from the integration time step and the maximum number of timestep bisections.

Note: in the current release these two entries behave as though they were interchanged — the value entered as *Minimum Acceleration* is applied as the minimum time criterion and the value entered as *Minimum Time Criterion* is applied as the minimum-acceleration threshold — and the minimum time criterion is then reset unconditionally to 1.0e-7. The practical effect is that the minimum time criterion is always 1.0e-7, and the *Minimum Time Criterion* entry is what actually sets the minimum-acceleration threshold (with the acceleration-zeroing test disabled at its 0.0 default).

Updated to match the current version of HVE.

Reports & Output

Dialog and feature reference for the HVE **Reports & Output** area, converted from the on-line help and verified against the current release. Part of the HVE Manual.

Pages

- Accident History
- Collision Pulse In-Use Factors Dialog Box
- Collision Pulse Options Dialog Box
- Collision Pulse
- Common Reports Dialog Box
- Common Scene Report Dialog
- Damage Data
- Trajectory Report
- Variable Output Edit Dialog
- Variable Output: Graph Dialog
- Variable Output Report
- Selecting Variables

Accident History

The Accident History output report is a table of positions and velocities describing the motion of each object during the event. The report is displayed in a scrollable Common Reports window (see the Common Reports Dialog Box topic); it contains no editable controls.

The exact contents of the report depend on the physics program that produced the event:

Path-based Programs (e.g. EDGEN)

The report is a table of positions and velocities for each user-entered path position. Rows are labeled *Initial:*, *Posn. n* and *Final:* (or *Rest:*), and include:

- **Time** — time at which the object reached the position
- **X, Y, Z** — earth-fixed coordinates of the position
- **Roll, Pitch, Yaw** — orientation angles at the position
- **V-tot** — total velocity
- **Sideslip** — sideslip angle
- **u-vel, v-vel, w-vel** — body-fixed linear velocity components
- **Roll vel, Pitch vel, Yaw vel** — angular velocity components

Collision Simulation Programs (e.g. EDSMAC4, SIMON)

The report is a table of positions and velocities at key phases of the collision sequence. Rows are labeled *Start of Simulation*, *At Impact*, *At Separation* and *At Final/Rest*, and include time, position (X, Y, PSI), total velocity, body-fixed velocity components, yaw velocity and Delta-V.

For these programs, the times reported for the impact and separation phases are determined according to the **Accident History Basis** calculation option (*Force* or *Acceleration*), selected in the event's Calculation Options dialog.

Updated to match the current version of HVE.

Collision Pulse In-Use Factors Dialog Box

It may be useful to study the sensitivity of the occupant motion to changes in the magnitude of the collision pulse. The Pulse Factors dialog (title:

Collision Pulse In-use Factors: [vehicle name]

) allows the user to quickly assign multipliers to each degree of freedom.

Each factor is entered as a multiplier (%/100) using a slider or its associated edit field. The allowed range is 0.0 to 2.0; the default value is 1.0 (no scaling).

Forward (%/100)

Multiplier applied to the forward component of the vehicle's linear acceleration.

Lateral (%/100)

Multiplier applied to the lateral component of the vehicle's linear acceleration.

Vertical (%/100)

Multiplier applied to the vertical component of the vehicle's linear acceleration.

Roll (%/100)

Multiplier applied to the angular acceleration about the vehicle's roll axis.

Pitch (%/100)

Multiplier applied to the angular acceleration about the vehicle's pitch axis.

Yaw (%/100)

Multiplier applied to the angular acceleration about the vehicle's yaw axis.

OK / Cancel

OK validates and assigns the factors; Cancel discards the changes. The factors are reset to 1.0 when **New** is pressed in the Collision Pulse dialog.

Updated to match the current version of HVE.

Collision Pulse Options Dialog Box

The user may need to select a portion of the total pulse for use in a simulation. For example, an entire left turn may last 3 seconds, while the resulting collision with an oncoming vehicle lasts perhaps only 125 milliseconds. Thus, the user would like to extract that portion of the total pulse during which the collision occurs. This task can be performed using the Pulse Options dialog (title:

Collision Pulse Options: [vehicle name]

). The Pulse Options dialog is also used for assigning the impulse center for a 3-D impulse when the Force/Moment pulse type is used.

Threshold Accel

Minimum total acceleration required for a data point to be considered part of the collision pulse (applies only to acceleration pulses). Entered with a slider or edit field.

Tstart (sec)

Starting time of the pulse. Entered with a slider or edit field.

Impulse Center (in) - x

The X coordinate of the impulse center. Enabled only when the current pulse type is Force/Moment.

Impulse Center - y

The Y coordinate of the impulse center. Enabled only when the current pulse type is Force/Moment.

Impulse Center - z

The Z coordinate of the impulse center. Enabled only when the current pulse type is Force/Moment.

OK / Cancel

OK validates and assigns the options; Cancel discards the changes. The options are reset to zero when **New** is pressed in the Collision Pulse dialog.

Updated to match the current version of HVE.

Collision Pulse

The Collision Pulse dialog (title:

Collision Pulse: [vehicle name]

) is used to assign a collision pulse to the selected vehicle, for use by occupant simulation models. The top of the dialog contains a graph of the current pulse versus time; below it is a data grid containing the numeric pulse table.

Pulse Data Source

Drop-down list selecting where the pulse data come from. The list contains:

- The current file name (or an *Untitled* entry for manually entered data). Pulse data may be typed directly into the data grid or loaded from a file using **Open...**.
- Each other event in the current case that (a) includes the same vehicle and (b) produces the currently selected pulse type. Selecting an event imports the pulse calculated by that event's simulation.

Pulse Type

Drop-down list selecting the type of pulse. Possible entries are:

- **Position** — position vs. time (X, Y, Z, Roll, Pitch, Yaw)
- **Velocity** — velocity vs. time (u, v, w, roll, pitch and yaw velocities)
- **Acceleration** — acceleration vs. time (linear and angular acceleration components)
- **Force/Moment** — force and moment vs. time (Fx, Fy, Fz, Mx, My, Mz)

Only the pulse types supported by the current event's physics program are shown. The columns in the data grid (Time plus six degrees of freedom) change according to the selected type. Changing the type after entering data prompts for confirmation because the existing table is discarded.

Data Grid

Editable table of pulse values: one row per time point, with a Time column followed by the six degree-of-freedom columns for the selected pulse type. Data may also be pasted from the clipboard.

Apply

Validates the entered table and saves it to the event without closing the dialog, then redraws the graph.

Print...

Saves the current table and prints the pulse graph.

Factors...

Displays the Collision Pulse In-Use Factors dialog, used to assign a multiplier to each degree of freedom of the pulse.

New

Clears the pulse table (after confirmation if data have been entered), resets the data source to

Untitled

, resets the pulse options (threshold, Tstart, impulse center) to zero and the in-use factors to 1.0, and redraws the graph.

Open...

Displays a file dialog for loading a pulse from a file. The file filter depends on the selected pulse type: `*.PosPulse` (position), `*.VelPulse` (velocity), `*.AccPulse` (acceleration) or `*.ImpPulse` (force/moment).

Save As...

Saves the current pulse table to a `.PosPulse`, `.VelPulse`, `.AccPulse` or `.ImpPulse` file, according to the selected pulse type.

Options...

Displays the Collision Pulse Options dialog, used to extract a portion of the total pulse and, for a Force/Moment pulse, to assign the impulse center.

OK / Cancel

OK validates and saves the pulse data and closes the dialog; Cancel discards the changes.

Updated to match the current version of HVE.

Common Reports Dialog Box

This window is used for displaying the numeric (text) output reports produced in Playback mode. It is a resizable, scrollable report window: the report text may be scrolled vertically and horizontally using the scroll bars or the mouse wheel. The window has no buttons; it is closed with its system menu close box.

The Common Reports window is used to display the following report types:

- **Accident History** — table of positions and velocities for the event (see the Accident History topic)
- **Damage Data** — vehicle damage results (CDC, PDOF, crush profile, delta-V, energy)
- **Driver Data** — driver control input tables (steering, braking, throttle, gear)
- **Environment Data** — description of the environment used by the event
- **Event Data** — event setup data (positions, velocities, event options)
- **Human Data** — human parameter data for humans in the event
- **Injury Data** — computed occupant injury measures
- **Messages** — informational, warning and error messages produced by the physics program
- **Program Data** — physics program name, version, calculation options and execution information
- **References** — technical references for the physics program
- **Results** — general simulation/reconstruction results
- **Vehicle Data** — vehicle parameter data for vehicles in the event
- **Event Notes** — user-entered notes attached to the event

Graphic reports (Site Drawing, Damage Profiles, Momentum Diagrams) are displayed in the Common Scene Reports window instead, and the Variable Output and Trajectory Simulation reports have their own dedicated windows.

Updated to match the current version of HVE.

Common Scene Report Dialog

This resizable window is used for displaying graphic output reports in Playback mode. The body of the window is a 3-D render area showing the selected report:

- **Site Drawing** — a scaled drawing of the environment
- **Damage Profiles** — the vehicle damage profiles (displayed in this window for reconstruction events; simulation events use the dedicated Damage Profiles report window)
- **Momentum Diagram (Scene)** — the momentum analysis diagram drawn over the scene
- **Momentum Diagram (Damage)** — the momentum analysis diagram drawn with the damage data

Next

Visible only for Momentum Diagram reports. Advances the display to the next phase of the momentum analysis. The diagram is built up in six phases; pressing Next after the last phase wraps around to the first.

Previous

Visible only for Momentum Diagram reports. Steps the display back to the previous phase of the momentum analysis, wrapping from the first phase to the last.

Updated to match the current version of HVE.

Damage Data

The Damage Data dialog allows the user to assign a damage profile to the selected vehicle. The damage profile is obtained by post-crash inspection of the vehicle, and provides a significant amount of useful information about the collision.

The right side of the dialog contains a graphic pane that draws the vehicle outline, the damage profile, the impulse center and the PDOF arrow; the drawing is updated as values are edited.

CDC

HVE's Damage Data dialog requests the user for a Collision Deformation Classification (CDC), a seven-character code describing the vehicle damage. The CDC is an SAE Recommended Practice.

The entered CDC is used to define a default PDOF and damage profile, which includes damage width, depth and location. The default data provided by the CDC are used to fill in the fields in the Damage Data dialog. The resulting delta-V, damage energy and peak force are calculated and displayed in the dialog. The delta-V is used to assign a default value of equivalent barrier speed (EBS) for the selected vehicle. If an invalid CDC is entered, the damage profile fields are grayed out until it is corrected.

PDOF (deg)

Simply stated, the PDOF is the direction of the impulse. This, of course, has physical significance, because the direction of the impulse is the same as the direction of the delta-V. In fact, because the damage analysis has no way of computing the forward and lateral components of the delta-V, the user-entered PDOF is used for this purpose.

The PDOF is assigned by the CDC as the closest hour angle (or clock direction). The Damage Data dialog displays the resulting PDOF in degrees. This value may be edited by the user if a more precise value is known (note that the precision of the clock direction is limited by the number of degrees in one hour, or 30 degrees).

Use Newton's 3rd Law

Checkbox. When checked, the PDOF edit field is disabled and the PDOF is calculated automatically so that it is consistent with the damage data assigned to the other vehicle in the collision (the impulses on the two vehicles must be equal and opposite). Uncheck this option to enter the PDOF manually.

Impulse Center (in) - x

Vehicle-fixed X coordinate of the impulse center.

Impulse Center - y

Vehicle-fixed Y coordinate of the impulse center.

Basis

Radio buttons selecting the basis used for the vehicle's damage data:

- **EES** — Select EES (equivalent energy speed; the radio button is captioned "EES" on screen) as the basis for the damage data. When selected, the EBS field below (the separate numeric edit, labeled "EBS") is enabled and the damage profile fields (zones, width, offset, crush depths, A Stiff, B Stiff) are disabled.
- **Damage Profile** — Select Damage Profile as the basis for the damage data. When selected, the damage profile fields are enabled and the EBS field is disabled.

EBS (EES)

Equivalent Barrier Speed: the speed at which the vehicle would have sustained the same amount of damage if it had struck a fixed rigid barrier.

Damage Profile (zones)

Drop-down list selecting the number of crush zones in the damage profile, from *1 zone* to *9 zones*. The number of zones determines the number of crush depth measurements (number of zones + 1) shown in the crush depth table.

Width (in)

The Damage Width is the width of the damage region. The default value assigned by the CDC does not include induced damage (non-contact damage adjacent to the area of actual contact with another vehicle). In most cases, the user should include induced damage if the goal is to estimate delta-V.

Offset (in)

The longitudinal or lateral distance from the CG to the midpoint of the damage profile.

Crush Depth Table (Data Grid)

Table defining the damage profile. Each row is one crush measurement location (C1, C2, ... Cn, where n = number of zones + 1) with an editable **Crush Depth** (in) value. Default depths are assigned from the CDC and may be edited.

Delta-V Total (mph)

Change in velocity during the collision; total magnitude. Read-only, calculated from the damage data.

Delta-V Long (mph)

Change in velocity during the collision; longitudinal component. Read-only, calculated from the damage data.

Delta-V Lat (mph)

Change in velocity during the collision; lateral component. Read-only, calculated from the damage data.

Damage Energy (ft-lb)

Energy dissipated by crush during the collision. Read-only, calculated from the damage data.

Peak Force (lb)

The peak collision force. Read-only, calculated from the damage data.

A Stiff...

Displays the A Stiffness Coefficients dialog: the force per unit of damage width required to initiate measurable (permanent) damage, for each crush zone. Enabled only when the basis is Damage Profile. Default values come from the CDC's damaged side (front, back or side).

B Stiff...

Displays the B Stiffness Coefficients dialog: the force per unit of crush depth per unit of damage width required to cause the measured damage, for each crush zone. Enabled only when the basis is Damage Profile.

Apply

Validates the current entries, recalculates the delta-V, damage energy and peak force, and updates the damage profile drawing without closing the dialog.

OK / Cancel

OK validates and saves the damage data and closes the dialog; Cancel discards the changes.

Updated to match the current version of HVE.

Trajectory Report

The Trajectory Simulation output window is a dynamic visualization of the human and vehicle motion, the same as during Event mode, beginning at the user-entered initial position and continuing until the end of the simulation. Like other output reports, Trajectory Simulations are displayed in a resizable Playback window selected from the Playback Window (report preview) dialog.

The window consists of a single 3-D render area showing the animated event; it has no buttons of its own.

The motion in the Trajectory Simulation window is controlled using the Playback Controller (play, stop, step and the time slider on the toolbar). When more than one Trajectory Simulation window is open, the playback controls act on the currently active window. Only one Trajectory Simulation window may be opened per event.

Updated to match the current version of HVE.

Variable Output Edit Dialog

The developer of a human or vehicle simulation model may choose to make certain simulation results editable by the HVE user. For example, a 2-D simulation may allow the user to edit the sprung mass Z position and roll and pitch orientations. By editing these non-calculated fields, the user can create a 3-D sequence using a 2-D program.

This dialog is displayed by pressing **Edit...** in the Variable Output report window. If the current event's simulation model exposes no editable variables, an error message is displayed instead.

Data Grid

Spreadsheet-style table of the editable variables:

- The first column, **Time**, is read-only; one row is created for each output time step of the simulation.
- Each remaining column is one editable variable (with its units), containing the current value at each time step. Type new values directly into the cells.

OK / Cancel

OK validates the entries, stores the edited values back into the event's variable output data and refreshes the Variable Output table; Cancel discards the edits.

Updated to match the current version of HVE.

Variable Output: Graph Dialog

The Variable Output Graph dialog is displayed by pressing **Graph...** in the Variable Output report window. It produces an XY plot of the currently selected output variables versus time.

Graph

The plot area fills most of the dialog. Up to the first six selected variables are graphed as separate series, each drawn in a distinct color with a legend entry showing the object and variable name. Values are plotted against simulation time on the X axis, in the current user units.

If more than six variables are selected in the Variable Output table, only the first six are graphed.

Print...

Prints the current graph.

OK / Cancel

Both buttons close the graph dialog and return to the Variable Output report window.

Updated to match the current version of HVE.

Variable Output Report

The Variable Output table is a special output table of simulation results for an individual event, displayed as a function of time. The Variable Output table can show a tremendous amount of data and is scrollable both horizontally and vertically. The window is resizable.

Select...

Pressing Select displays the Variable Selection dialog, used to choose the variables (per object and output group) displayed in the table.

Graph...

The Graph button produces a graph of the first six selected variables in the Variable Output table (see the Variable Output Graph dialog).

Edit...

Each HVE simulation event produces results calculated by the simulation model. Certain non-calculated results may also be assigned by the simulation model; these non-calculated results are editable by the user. Pressing Edit displays the Variable Output Edit dialog for those variables. If the model exposes no editable variables, an error message is displayed.

Data Grid

Table of output values. The first column is Time (one row per output interval); each remaining column is one selected variable, with a multi-line column header showing the object name, the variable name and its units (tire variables include an additional axle/side line).

Selected cells may be copied to the clipboard by pressing **Ctrl+C**; the copied block is tab-separated and includes the column headers, ready for pasting into a spreadsheet.

Updated to match the current version of HVE.

Selecting Variables

The Variable Selection dialog is used for selecting the variables to be displayed in the Key Results window (Event mode) and in the Variable Output table (Playback mode). The same dialog serves both purposes; the set of available groups and variables is supplied by the physics program for the current event.

This dialog contains the following items:

Object Name

A combo box containing the names of all the humans and vehicles in the current event. Variables are selected per object; choose the object whose variables you wish to select.

Current Group

Read-only display of the output group currently selected in the Output Groups list.

Output Groups

List of the available variable groups (e.g. accelerations, velocities, positions, tire data, belt and airbag data) for the selected object. Choose the desired group from the list; the Variables list is filled with that group's variables.

Variables

Displays all the variables available for the selected group. Choose the desired variables from the multiple-selection list box. Selected variables are highlighted. Click on any highlighted variable to deselect it.

Clear Selection

Deselects all the selected variables in the current group.

Clear All Selections

Deselects every selected variable in all groups for the current object. A confirmation dialog is displayed first (with a "don't ask again" option).

Select All

Selects all the variables in the current group. This button (and All Groups/Vars) is shown only when the dialog is invoked for variable export; it is hidden for ordinary Key Results and Variable Output selection.

All Groups/Vars

Selects every variable in every output group for the current object. Shown only when the dialog is invoked for variable export.

OK / Cancel

OK accepts the selections and updates the Key Results window or Variable Output table; Cancel discards the changes.

Updated to match the current version of HVE.