

SIMon

User Guide



What is SIMon

The *SIMon* (Simulated Injury Monitor) computer code is a PC Windows application that enables a user to retrieve measured data from crash dummy tests, manipulate and transform the data, display results, and make injury assessments. *SIMon* combines in a single package several analysis modules previously developed by DOT/NHTSA. Presently, the focus of *SIMon* is the analysis and utilization of nine accelerometer package (NAP) data, relating to the motion of the head. An assessment for head injury is provided by means of a state-of-the-art finite element brain injury model integrated in the code. The source of the required data can be either an existing test in a NHTSA supplied database, or new tests that can be added to a separate user database - created, maintained and displayed automatically by *SIMon*. Acceleration time history data can be in UDS or ASCII file format. The relevant data files are selected by a simple drag and drop operation. Injury assessment of other body regions, such as the neck, thorax, and lower extremities, are planned for future code development.

What are the system requirements?

SIMon requires an MS Windows 98, 2000 or XP operating system. *SIMon* has not yet been tested on Windows NT. It is highly recommended that the CPU speed be at least 700 MHz. *SIMon* will be quite slow, but will work with a 200 MHz PC. For the best performance, 128 MB or more of RAM is recommended, with the minimum being 64 MB. The hard drive storage requirement for installation is approximately 110 MB. However, invoking the brain model typically entails an additional 300 Mb of disk space for each crash test simulated. A CD-ROM drive is required for installation. It is recommended that screen resolution be at least 1024 × 768. The minimum acceptable resolution is 800 × 600. If the minimum resolution is used, Windows must be set up for Small Fonts (the default when Windows is first installed). Otherwise, *SIMon* dialogs will be too large for the screen. Large Fonts are acceptable with resolutions greater than 800 × 600. True color (24 bit) is the preferable graphics mode, but 256 colors or high color (16 bit) are also acceptable.

How is SIMon installed?

SIMon is installed from a CD-ROM, by running *setup.exe* in its root directory. Typically, *setup.exe* is run automatically upon inserting the CD-ROM. Complete instructions are provided with the CD-ROM.

What is the present code version?

The current version of *SIMon* is denoted as *SIMon 3.0 Beta*, with a release date of October 26, 2003. The *SIMon* version can be verified by clicking on the **About** button of the Welcome dialog.

Starting SIMon

SIMon is started by double-clicking the *SIMon* desktop icon, or by double-clicking the file *simon.exe* in the *SIMon* installation directory using Explorer. Upon entering *SIMon*, the user should click on a pictured crash dummy of interest, from among a HYBRID III 50% male, 5% female, 6 year old child, 3 year old child, or a CRABI 12 month old infant (Figure 1). Presently, it does not matter which dummy is selected. (A future version of *SIMon* might employ dummy-specific analyses.) A full size picture of the crash dummy selected then appears (Figure 2). A body region of interest is selected by clicking on this picture. An appropriate dialog for analysis then appears. If the head is selected, a HEAD INJURY – TEST DATA SELECTION applet is shown, allowing computation of rotational accelerations from measured data for translational accelerations. Presently, the only body region addressed by *SIMon* is the head. In the various applets that are described subsequently, the user should click on the **Close** button to return to the previous dialog. Alternately, the “X” control button at the upper right of the Windows frame can be used for this purpose.



Figure 1.

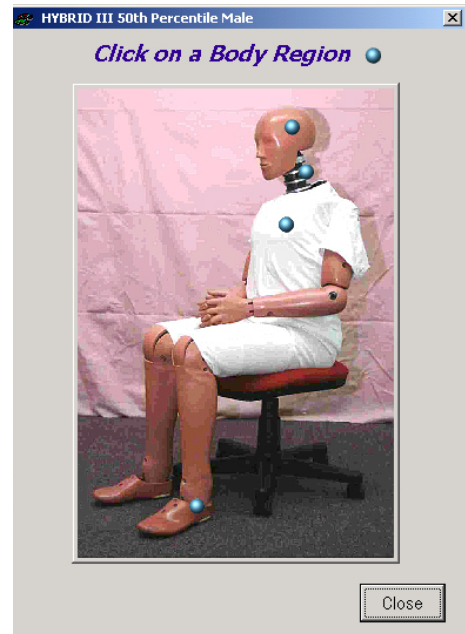


Figure 2.

Exiting SIMon

To exit a *SIMon* session, simply return to the initial window picturing the five crash dummies, and click on the **Exit** button at the lower right of the screen. Alternately, use the **Exit All** button on the NAP applet described in the next section.

Using Help

A comprehensive Help system following the Windows protocol is implemented in *SIMon*. To invoke help, simply press the **F1** button in any dialog, or click on a **Help** button. Generally, if a **Help** button appears in a dialog, it will invoke context sensitive help, while clicking **F1** will bring up the Help system Table of Contents. It is highly recommended that a new *SIMon* user refer to the **Quick Start** topic of the *SIMon* help system. Additional help can be obtained without entering the Help system by simply holding the cursor over a control (e.g.- command button, option button or check box) in a *SIMon* dialog. A brief pop-up message will appear, displaying “ToolTip” help.

Analysis of Nine Accelerometer Package data

The HEAD INJURY – TEST DATA SELECTION applet is invoked by clicking on the blue hotspot located on the head of any full size picture of a crash dummy, and is shown in Figure 3. With this applet, the user can select a test to be analyzed. A list box of tests appears at the upper left of the dialog, as seen in Figure 3. Tests can be present in either a NHTSA supplied database (included with the *SIMon* installation), or in a separate database created and maintained by the user. If a test is to be selected from the NHTSA database, check the box entitled “Use NHTSA database?” A demo mode is automatically activated upon installation of *SIMon*. In this mode, only one test will appear in the list box titled “NHTSA Test Number”. This is because raw data are only supplied for this one test, although all tests are in the database. Raw data are stored in a separate directory from that containing the database. The user can deactivate the demo mode by means of the “Settings” dialog, in which case all of the NHTSA tests will appear in the list box and are selectable.

To select a test, simply click on the test number in the list box. The button **NAP Analysis** will then be enabled, and the database fields for this test will appear in the display. Proceed to analysis of NAP data and head injury assessment by clicking on the **NAP Analysis** button.

You can view the NHTSA database by selecting the **View Database** button of this dialog before or after proceeding to the HEAD INJURY – NAP ANALYSIS dialog

HEAD INJURY - TEST DATA SELECTION

NHTSA Test Name

1970
2039
2040
2041
2042
2043
2044
2045

☒ Use NHTSA database?

New Edit Delete

NAP Analysis Ang Vel Devices Help Close

Test Name: 2041 View Database Settings Exit All

Test Title: THORACIC/ABDOMINAL TRAUMA FROM IMPACT WITH STEERING

Test Configuration: PENDULUM

Test Objective: GATHER CADAVER THORACIC/ABDOMINAL INJURY DATA IN IMPACTOR TEST.

Test Date: 2/27/1987 Test Reference: SR1-CM50 Test Performer: CALSPAN

Contract Number: DTNH22-83-C-47019 Contract Monitor: MORGAN Closing Speed (km/hr): 37.498

Test Comments: IMPACTOR'S WEIGHT IS 60.1 LBS. DATA SPIKE OCCURS AROUND 300 MSE Impact Angle (deg): 0

Status: SELECT 'NAP Analysis' or 'Ang Vel Devices' ...

Figure 3.

HEAD INJURY – NAP ANALYSIS applet

The HEAD INJURY – NAP ANALYSIS applet is invoked from the HEAD INJURY – TEST DATA SELECTION applet described above, and is shown in Figure 4. Upon entering this dialog, the cursor becomes an hourglass, indicating that NAP computations are in progress. During this time, rotational accelerations in body-fixed and inertial frames of reference are computed from the nine translational accelerations comprising the raw NAP data. Upon completion of the NAP calculations, the angular acceleration can be plotted by selecting the appropriate option button in the “Plot Selection” box. The resultant of head acceleration, the angular velocity and angular displacement can also be plotted. In the case of resultant acceleration, there is only one component, and it is shown as a single plot at the bottom of the dialog. The user can view all nine components of the translational acceleration by clicking on the left and right arrows to the right of the first plot option button. The raw acceleration data are plotted immediately upon entering this dialog, and for the first three gauges they are displayed while the NAP computations are in progress. The NAP computations typically take just a few seconds on a PC with a 700 Mhz CPU.

The HEAD INJURY – NAP ANALYSIS applet includes displays of the initial NAP gauge rotation, initial velocity, and arm lengths, as obtained from the database for the test selected. Values of these quantities can be changed by the user, and the NAP calculation repeated, using the **Recalc** button at the top of the dialog.

The **NAP Data Consistency** button invokes a dialog containing a plot of the raw data for each of the nine acceleration traces, overlayed with data predicted from a rigid head finite element calculation, using the loading deduced from the original data. The FE calculation typically entails tens of seconds, depending on the duration of the data and speed of the CPU.

The value of Head Injury Criterion (HIC) can be viewed by selecting the button **HIC**. A small window will appear showing the HIC value obtained from the resultant acceleration computed from raw data for NAP gauges 1-3. The **SFC** button is used to view the Skull Fracture Criterion. A window will appear displaying the value of SFC and probability of skull fracture. A plot of probability vs. SFC is also shown.

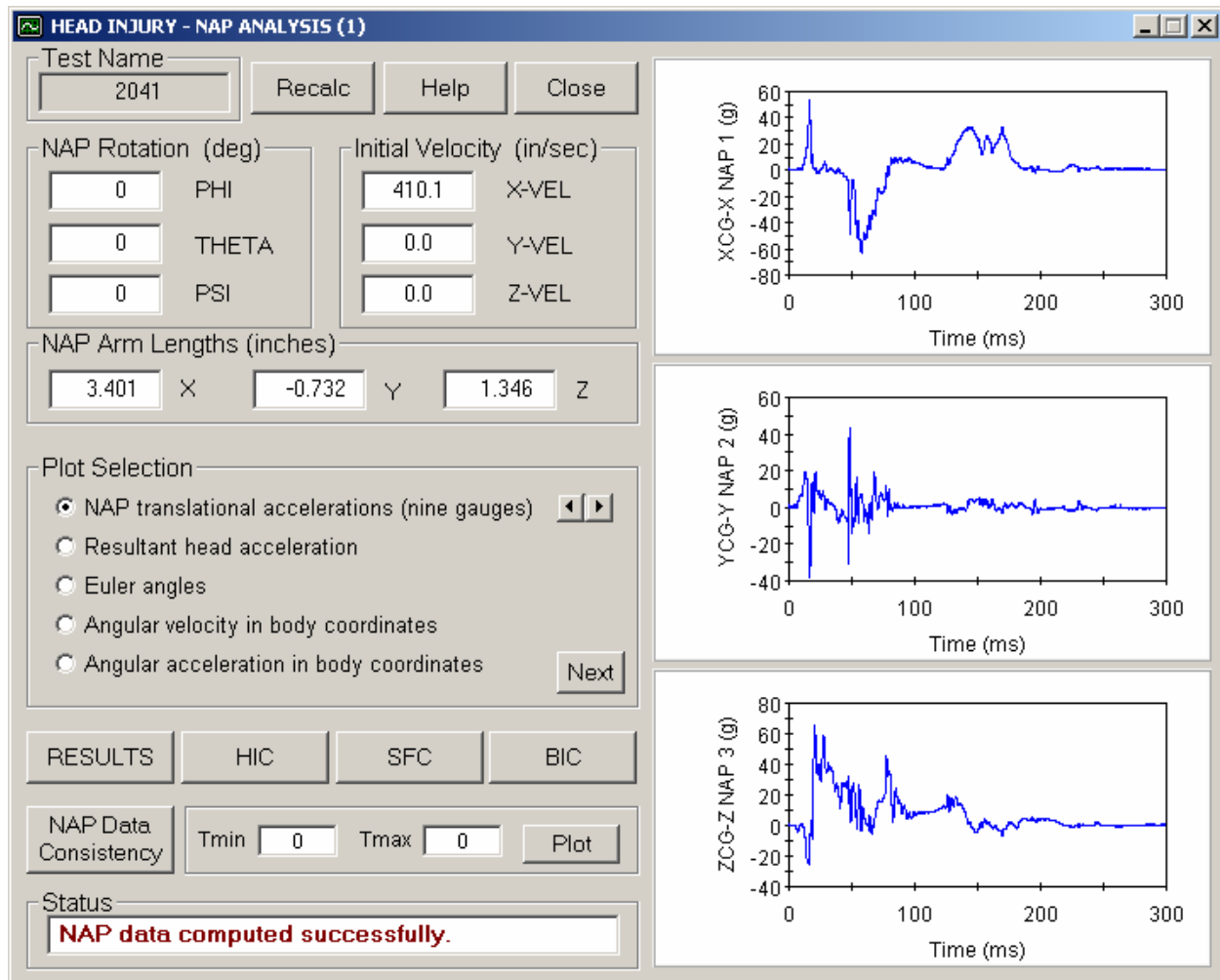


Figure 4.

The plotting limits of time, in units of ms, can be changed by use of the “Tmin” and “Tmax” text boxes that appear near the bottom of the HEAD INJURY – NAP ANALYSIS window. Click on **Plot** to refresh the plots. To reset to the default limits, set both Tmin and Tmax to zero.

A summary of the NAP calculated data can be displayed by clicking on the **RESULTS** button near the lower left of the dialog. The summary includes peak values of translational and rotational displacements and accelerations.

SIMon includes a finite element head injury model that can be invoked from the HEAD INJURY – NAP ANALYSIS dialog by clicking on the **BIC** button. The BIC applet is described later in this User’s Guide.

Adding a new test for NAP analysis

The user can import raw NAP data into **SIMon** and create a test entry in a user database. To import user data, the check box “Use NHTSA database?” must be unchecked in the HEAD INJURY – TEST DATA SELECTION dialog discussed earlier. When this box is unchecked, the title for the list box of selectable tests becomes “User Test Name”, and the buttons **New**, **Edit** and **Delete** below this box are enabled. Some sample user tests may be included with the **SIMon** installation, and will appear in the list box. The test names for user tests can be assigned 1 to 12 alphanumeric characters. Any character allowed in Windows directory names can be used. User test names can be assigned names that are numbers of the supplied NHTSA tests. In that case, of course, they would represent different test data. The ADD TEST dialog is shown in Figure 5. The user should drag and drop the files containing NAP data into the panel labeled “NAP Gauge Files”. Data for each of the nine NAP gauges must be placed in its own distinct file. For a given test, the files should all be from the same directory. After the files are inserted in the dialog, their relative placement in the list must correspond to the labels “XCG – X”, “YCG – Y”, etc., to the left of the list box. Multiple file selections from the Explorer are allowed, and are always inserted in alphabetical order. The final order can be changed by use of the **SORT**, up arrow (▲), and down arrow (▼) buttons. Select one or more files in the list and click on the appropriate button to change the order. Files can be in either UDS or simple text format. For simple text, the files must have two columns of data in free-field format, the first column being time, and the second column acceleration. Header lines, including lines with a sample count, must not be present. An option button in the “File Type” panel allows the user to choose the file format. Units of time and acceleration are selected in pull-down lists to the right of the File Type selection option buttons.

The user must always provide a test name in the box at the top left of the ADD TEST applet. The NAP rotation, initial velocity and arm lengths should be specified in the text boxes to the left of the dialog, as shown in Figure 5. These data are stored in the user database for the test. Descriptive field data for the test, such as a title, objective, date and comments, can be entered in a separate dialog that appears when the **Enter Test Descriptor Data** button is selected. These data

are also stored in the user database. A button with the Explorer icon, at the bottom center of the dialog, moves the current window to the left and invokes the Windows Explorer, which appears to the right of the screen. The default path in the Explorer points to sample NAP data provided during the *SIMon* installation. The desired files can then be selected using Explorer and dragged and dropped into the ADD TEST dialog.

Figure 5.

To add the test data to the user database, click on the **Add Test** button. If a test number was not entered, an informative message is issued, and the test cannot be added. The user will be asked to confirm the addition of a test. To exit the ADD TEST dialog, use the **Close** button at the bottom right of the dialog.

The NAP acceleration traces that were dragged and dropped are automatically copied to a directory managed by *SIMon*, so the user can move or delete the original data after a test is added.

User tests can be deleted by means of the **Delete** button in the Head Injury – Test Data Selection applet. Select a single test to delete in the list box of user tests. Multiple test selections for deletion are not possible. The database entry for the test is deleted, but at present, the actual test data are not (with knowledge of *SIMon* directory paths described in a latter section, the user can delete the unwanted test data). Database entries for user tests can be modified by means of the **Edit** button in the HEAD INJURY – TEST DATA SELECTION dialog..

BRAIN INJURY CRITERIA applet

SIMon incorporates a finite element model (FEM) of the brain for head injury assessment. Input data for the model are assembled by *SIMon* using data output from a NAP calculation of a user test or NHTSA supplied test. The translational and rotational velocities of the head CG in an inertial frame of reference are used to construct appropriate load curves for an LS-DYNA 970 calculation. The FEM calculation typically requires several hours of computation time, depending on the time duration of the data, and on the CPU speed. During the calculation, and at the completion of a calculation, several measures of brain injury are plotted by *SIMon* in the BRAIN INJURY CRITERIA dialog

In order to invoke the head injury model, you must first bring up the HEAD INJURY – NAP ANALYSIS screen by selecting a test as discussed earlier. Click the **BIC** button on this screen and the BRAIN INJURY CRITERIA dialog then appears, as illustrated in Figure 6. The minimum and maximum extents in time of the NAP output velocity data used for constructing the load curves for the FE simulation can be specified by the user in the panel “Load Curves”. The default for the maximum time appears as the maximum physical time of the raw data. If the acceleration data does not begin until a certain physical time, it would be advantageous to “crop” the data for the load curve. The lower limit of time of the load curve is always mapped to a physical time of 0ms in the FEM simulation. The duration (physical time, not clock time) of the FE calculation can be specified by editing the text box “Duration of calculation”. Upon doing so, the entry in the “Maximum Time” text box is updated automatically to reflect the duration.

To initiate the FEM calculation, click on the **Run BIC Model** button at the top left of the BRAIN INJURY CRITERIA screen. The calculation is carried out in a batch mode, in a DOS window that will appear without delay. This window will contain some initial printed output from LS-DYNA 970. It is highly recommended that the DOS window be minimized using the minus (“–”) button at the top right of the window frame. The batch calculation will continue to run, and will appear as a task in progress in the Windows Task Manager. *Avoid clicking the close (“x”) control button, since this will terminate the calculation prematurely.*

Several BIC calculations can be in progress at the same time, although this will require additional computing resources (e.g.- RAM and disk memory). The user can exit the *SIMon* session and re-enter the BRAIN INJURY CRITERIA dialog with the same test number to check the progress of the FE calculation. Select the **Run Status** button at any time to check the run status. To determine when the calculation is finished after you have exited a *SIMon* session,

restore and examine the contents of the DOS window, or employ the Windows Task Manager. Alternately, view the contents of the file “messag” or “d3hsp” in the working directory for *SIMon*. These are the print files generated by LS-DYNA 970.

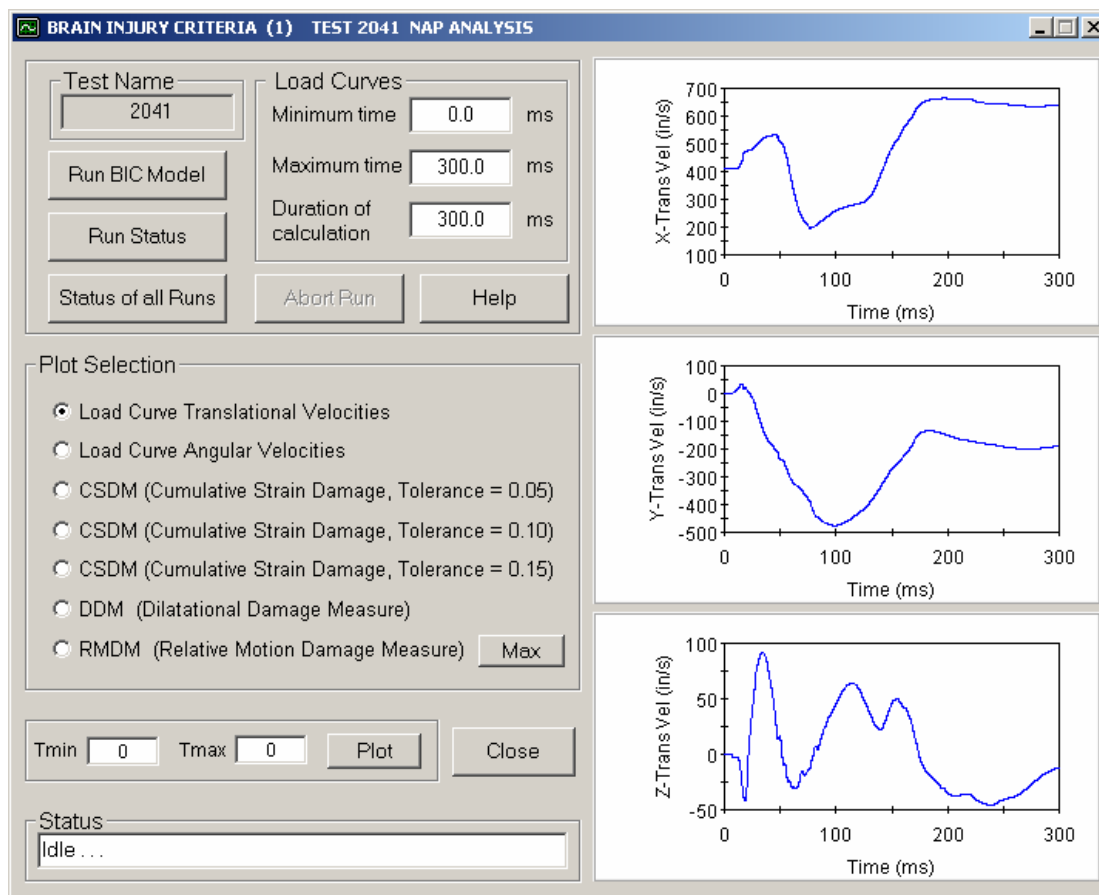


Figure 6.

At the conclusion of a BIC calculation, LS-DYNA 970 will write output data of special interest to files “vftime.dat” and “disp.dat” in the working directory for *SIMon*. Injury assessment criteria CSDM (Cumulative Strain Damage), DDM (Dilatational Damage Measure) and RMDM (Relative Motion Damage Measure) can be viewed in the BRAIN INJURY CRITERIA dialog by selecting the appropriate plotting option buttons. CSDM is available for three strain tolerance levels, 0.05, 0.10 and 0.15. Data for these quantities are found in the aforementioned output files. If the plot option buttons are clicked on before 1ms of physical time has been reached, an informative message will appear, indicating that the data are not yet available. During installation of *SIMon*, sample output files are placed in the working directory for test 3897, so the user will always be able to view results for that particular test in the BRAIN INJURY CRITERIA dialog.

The plotting limits in time for all plots shown can be changed by use of the “Tmin” and “Tmax” text boxes that appear near the bottom of the BIC dialog. Click on **Plot** to refresh the displays. To reset to the default, set both Tmin and Tmax to zero.

While a run is in progress, LS-POST2 can be used to view in 3-D the results of an LS-DYNA 970 calculation. To do so, execute the file “lspost20_wind.exe” found at the root of the *SIMon* installation CD-ROM. Then in LS-POST2, open the “d3plot” file in the directory C:\Simon\Work\testno\NAP\BIC (assuming that the installation directory is C:\SIMon).

Directory Paths – The *SETTINGS* applet

SIMon requires specification of several directory paths, in order to manage different types of data. Generally, the user need not be concerned with these paths, since the *SIMon* installation will assign default paths as subdirectories in a single user-specified installation directory. If the user wishes to control these paths, the *SETTINGS* dialog, shown in Figure 7, should be employed. This dialog can be displayed by clicking on the **Settings** button in the NAP applet (Figure 3). The *SETTINGS* applet includes provision for user entry of five directory paths pertaining to the: (1) NHTSA database, (2) NHTSA trace data, (3) user database, (4) user trace data, and (5) working directory for *SIMon*. The user database, user trace data and working directories must not correspond to read-only storage media. The NHTSA database and trace data can be supplied on CD-ROM media.

Caution should be exercised in modifying the default data paths. To do so requires that you first copy all data in existing paths into the new paths. Then the *SETTINGS* dialog can be used to specify the new paths.

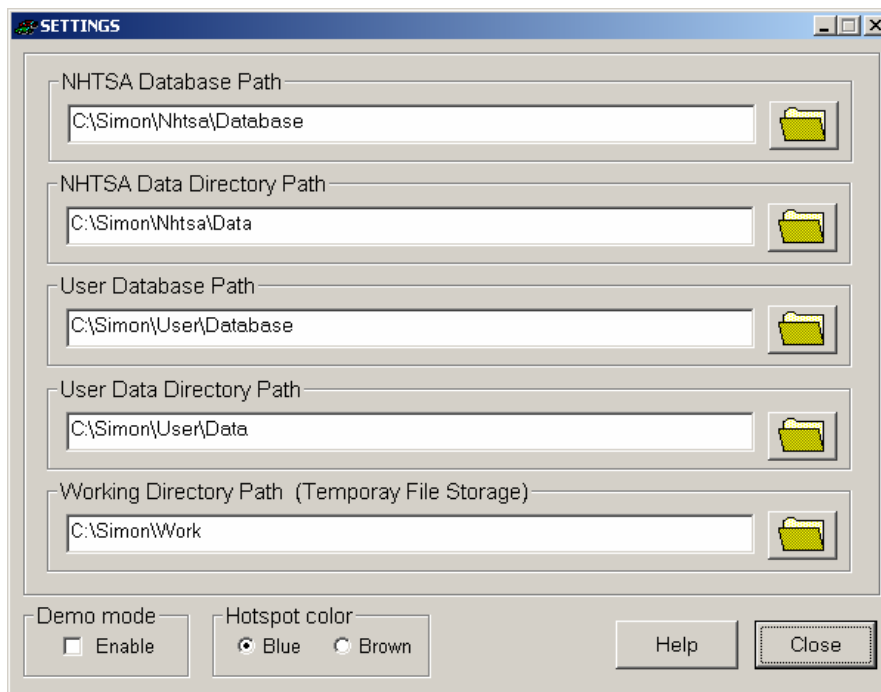


Figure 7.

By default, the required database files and trace data are placed in subdirectories of the *SIMon* installation directory. In order to place the program files in a directory totally separate from the data (on another drive, for example), it is necessary to modify the default directory paths by means of the SETTINGS applet. The default installation directory is C:\Simon.

SIMon maintains an “ini” file where the directory paths are stored. Hence, the specified paths will always be retained across *SIMon* sessions.

NAP Output Files

Upon performing a NAP calculation for a given test, relevant output data files are stored in the directory

C:\Simon\Work\testno\NAP\BIC

where *testno* denotes the 1 to 12 alphanumeric name of the test. (If during installation of *SIMon*, a different installation directory was specified, substitute that path for C:\Simon in the above.)

The data files created are all in ASCII format. With the exception of the two UDS files created, all files have the same structure. Each line contains four columns of fixed-field data, *t*, *q_x*, *q_y*, *q_z*, where *t* denotes time in ms, and *q_x*, *q_y* and *q_z* represent components along respective axes of the quantity relevant to that file (for example, rotational acceleration for file *bdrotacc.dat*.) The units vary with the quantity and are given below. Descriptions of each file now follow:

<i>bdrotacc.dat</i>	Rotational acceleration in a body-fixed frame (rad/s/s)
<i>bdrotvel.dat</i>	Rotational velocity in a body-fixed frame (rad/s)
<i>fxrotacc.dat</i>	Rotational acceleration in an inertial frame (rad/s/s)
<i>fxrotdis.dat</i>	Rotational displacement in an inertial frame (deg)
<i>fxrotvel.dat</i>	Rotational velocity in an inertial frame (rad/s)
<i>fxtrnacc.dat</i>	Translational acceleration in an inertial frame (g)
<i>fxtrndis.dat</i>	Translational displacement in an inertial frame (in)
<i>fxtrnvel.dat</i>	Translational velocity in an inertial frame (in/s)
<i>resaccn.uds</i>	Resultant acceleration computed from acceleration in body-fixed frame, resulting from the NAP calculation (g)
<i>resaccr.uds</i>	Resultant acceleration computed from raw NAP acceleration data (g)

The *dat* files each have an initial line containing the count of lines (time samples) to follow. Each subsequent line contains four values for *t*, *q_x*, *q_y*, *q_z*.

An additional text file created in the *testno* directory, *prntfile.txt*, contains printed output from the NAP computational module. The text file *loadcrv.txt* is also present, and contains load curves that can be input to the LS-DYNA 970 finite element calculation of the head.

The *SIMon* HEAD INJURY – NAP ANALYSIS applet has option buttons for display of the nine traces of raw NAP data, resultant head acceleration computed from the raw data, angular displacement in an inertial frame of reference, and angular velocity and acceleration in a body-fixed frame. With the exception of the raw NAP data, all of these quantities can be found in the NAP output data files described above.