PC3: Crash and Blast Analysis Post-Processor for Simulations and Live Tests

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Abstract

For crash and blast tests of vehicles and sub-assemblies, simulations play an important role in the prediction of the test results. Some of the most important results are the occupants' injury criteria, which are calculated by simulating ATDs and their various joints, accelerometers, etc'. Often in a simulation/test there are few ATDs, and there is an increasing demand for post-processing of the injury criteria in an automated way, as well as correlating the results between simulation and test, thus enabling easier calibration of the simulation. We present PC3 (Plasan Criteria Computation and Comparison), a software tool developed by Plasan Ltd., which enables easy calculation of simulation and test ATD results, and correlation of said results. Currently the program is able to read simulation data from LS-DYNA® binout database, and various test databases, such as ISO text files, CSV files, HDF5 database files and some others. An example of criteria calculation for blast simulation and test data will be shown, along with correlation between the two.

Note: Mr. Raz was unable to attend the conference;
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Introduction

In recent years the need for automated post-processing of blast/crash simulations has arisen, since the sheer number of simulations has increased dramatically, along with the demand for more accurate processing of said results and fast creation of simulation reports.
In addition, a simulation cannot be considered reliable until it was correlated with a live test and calibrated. When the simulation and test include several Anthropomorphic Test Dummies (ATDs), the correlation becomes even more complex.

A special software tool was created By Plasan Ltd., which simplifies the process of post-processing of ATD data by:

- Importing the raw data from simulations and tests
- Automating the calculation of injury criteria
- Enabling correlation between simulations and between simulation/live test
- Creating rich reports and exporting to Word

PC3 Raw data loading

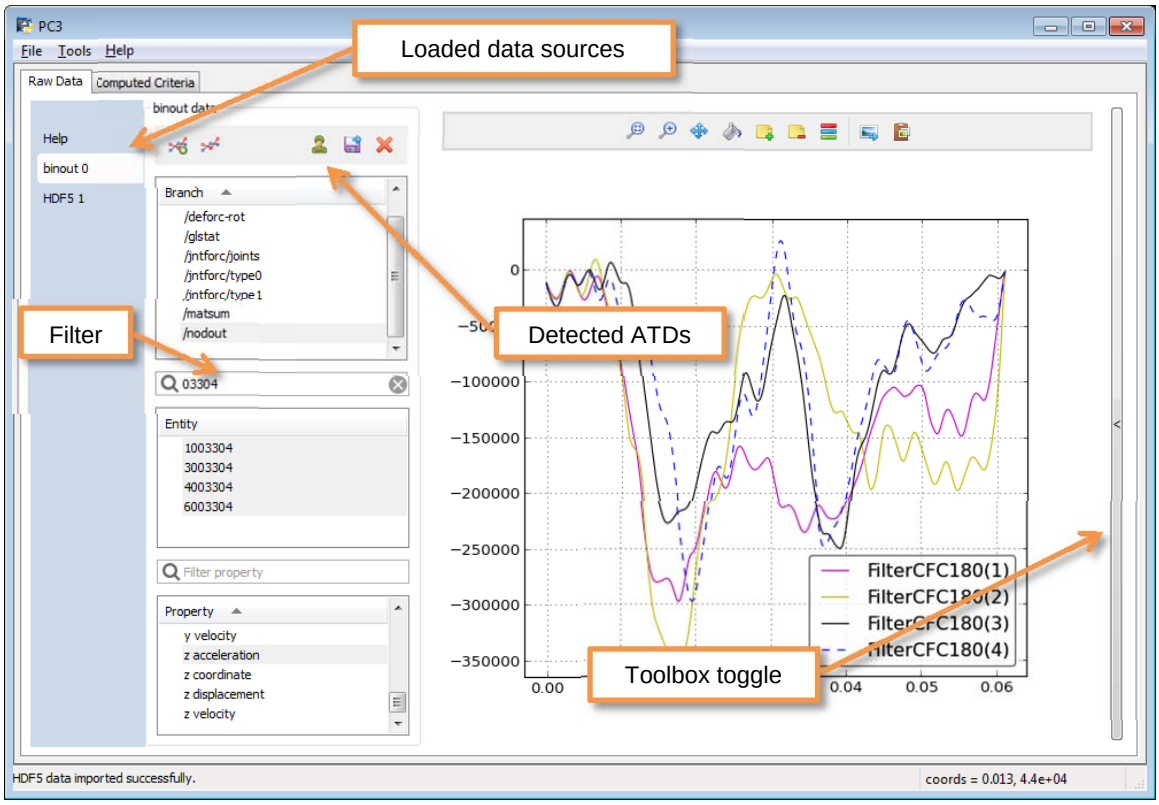

Figure 1: PC3 GUI overview. The main menu is available on top, and below it the main panels: (a) Raw data and (b) Computed criteria. Each panel has data tables at left and plot area at right

The GUI of the program is modern and simple. There are only two main panels to work with, the raw data panel and the computed criteria panel. All data is imported into the raw data panel, and all computed criteria is placed on the criteria panel. Figure 1 shows the GUI with binout data loaded and plotted, with other special features visible:

- Filtering and ordering of the binout lists is possible.
- All data sources are loaded and available for immediate plotting.
- Automatic detection of ATDs in the data

All raw data can be further manipulated via the toolbox (hidden in Figure 1), where the usual functions are available, such as integration, differentiation, resultant, etc., but also most of the functions used for the criteria calculation, such as DRI, Load-Duration, HIC and so on. Figure 2 shows the toolbox open, with the following features visible:

- Channels IDs 1÷4 were plotted from the loaded binout data, but are not shown.
- Channels IDs 5÷8 were computed from channels 1÷4 by filtering, and are shown in the plot area.
- The operation selected is: Filter → CFC180 → Time=[s], and can be applied to any selected channels.

After the data sources are loaded, and provided that ATDs were detected, criteria computation can begin. Data can be loaded from LS-DYNA binout database, as well as several test databases,

such as ISO text files, CSV files, and binary HDF5 files. Other database formats are easy to integrate and can be incorporated in the program in short amount of time, usually an hour or two.

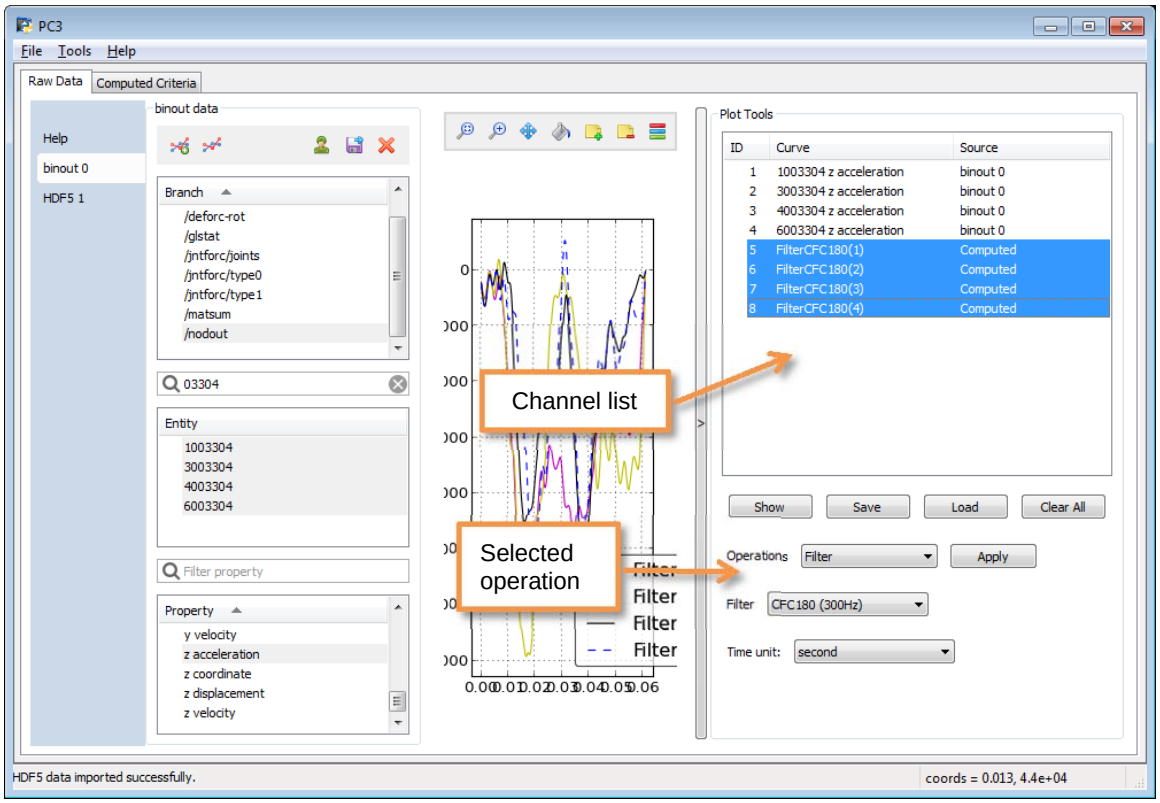

Figure 2: Toolbox open, with filtered channels shown in the plot area

PC3 Criteria computation

If data is loaded and ATDs are detected, the green ‘soldier’ icon will be enabled. Upon pressing it, the criteria computation dialog will appear, see Figure 3. Each ATD can optionally have a customized name to be shown in the computed criteria, otherwise the original name will be shown. Data units for input data and for the computed criteria have to be selected next. Optionally the end time of the source data can be limited, since sometimes test data is needlessly long. The last step is to choose the type of criteria to be computed.

After the computation is finished, the ‘Computed Criteria’ panel will be shown with the results of the computation. Figure 4 shows the computed criteria, with two data tables to the left and a plot area to the right. The top table shows criteria values in the selected units, while the bottom one shows all criteria as percent of the defined criteria limit.

When selecting a line in the table, the relevant criterion is selected to be plotted and is shown in the plot area. In Figure 4 the first line is selected, thus an ATD overview plot is shown.

All the criterion are computed according to published standards [1-5], where most of the low level code (filters, ODE integrations, HIC, etc.) is written in C for speed, and the high level code is vectored as much as possible.

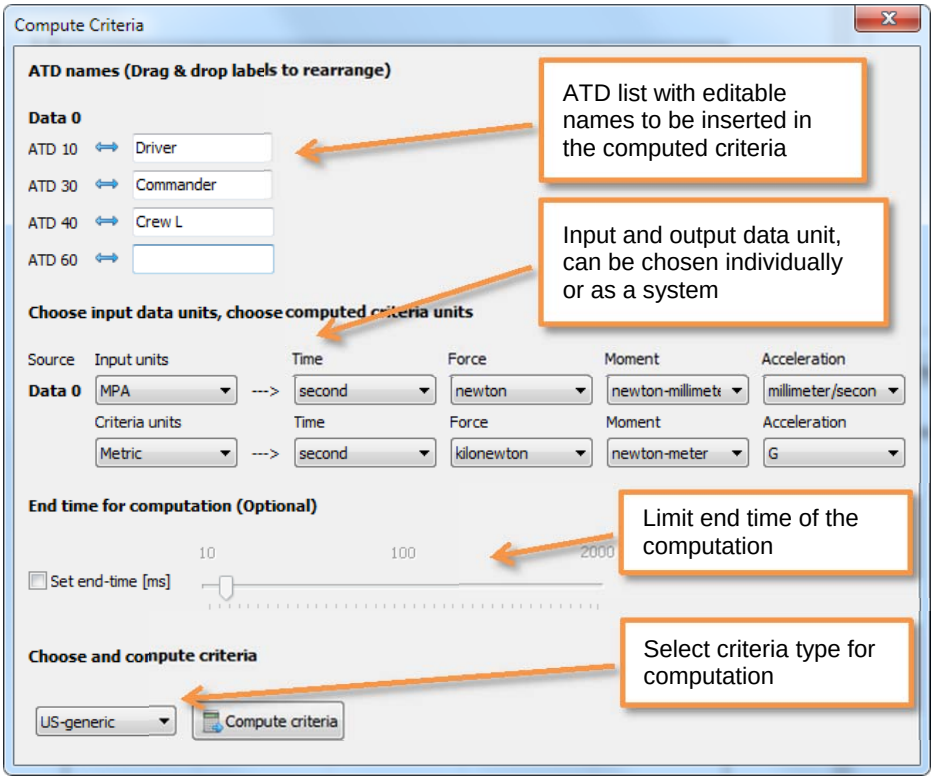

Figure 3: Criteria computation dialog

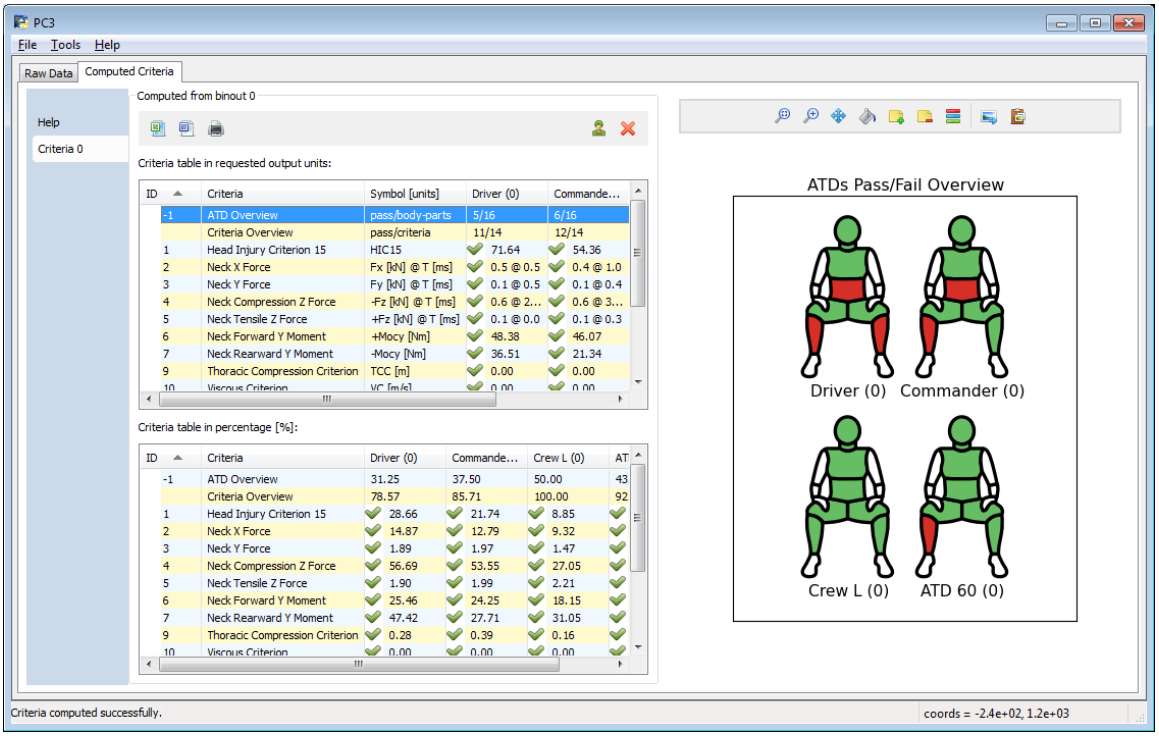

Figure 4: Computed criteria panel

PC3 Criteria comparison

If several data sources are loaded and ATDs are detected, the menu item Tools → Compare will be enabled. Upon pressing it the criteria computation dialog will open with all the data sources and detected ATDs shown as in Figure 6. Since the order of ATDs in the data is arbitrary, it is possible to reorder the ATDs by dragging them up and down. Input data units can be chosen for each data source individually. The rest of the dialog is the same as before.

When the computation is completed the criteria will be shown in the 'computed Criteria' panel. In the criteria tables the compared ATDs are next to each other, and in plots the compared ATDs have the same color but different line style, making them easy to compare. The orange frames in Figure 7 show these points.

Also in Figure 7, the criterion plot, in this case of 'Pelvis Z acceleration', can be seen. The plot contains all computed channels for this criterion, markers for the worst points on the curves (marked as 'Max values'), and the criterion curve itself in thick red. All aspects of the plot can be changed through a dialog which can be accessed on the plot toolbar.

Datacursors showing X and Y locations can be added and removed at will at any location along the curves, as shown by the yellow datacursor on Figure 7. Also implemented is the ability to show differences between two curves in the plot area.

PC3 Report generation

Once the criteria is computed for a single data source or as a comparison between several data sources, it is possible to export the results to two formats or to print them. Pressing the 'Print' button (see Figure 7) will open a dialog for immediate printing of the two criteria list.

Pressing the 'Export to Word' button will open a dialog that enables to export the two criteria list and all the plots to a word document, where it can be further edited as needed. It is possible to include/exclude the criteria plots in the reports, see Figure 5, but the two overview plots (ATD overview & Criteria overview) will always be exported.

Lastly, Pressing 'Export to Excel' button will export the two lists to an Excel file.

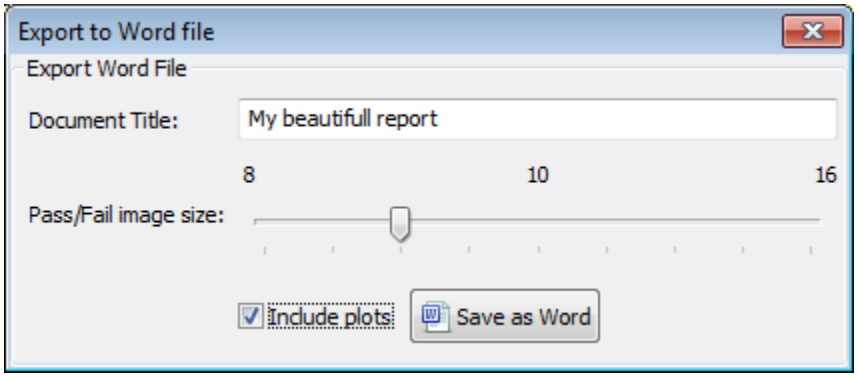

Figure 5: Word export dialog

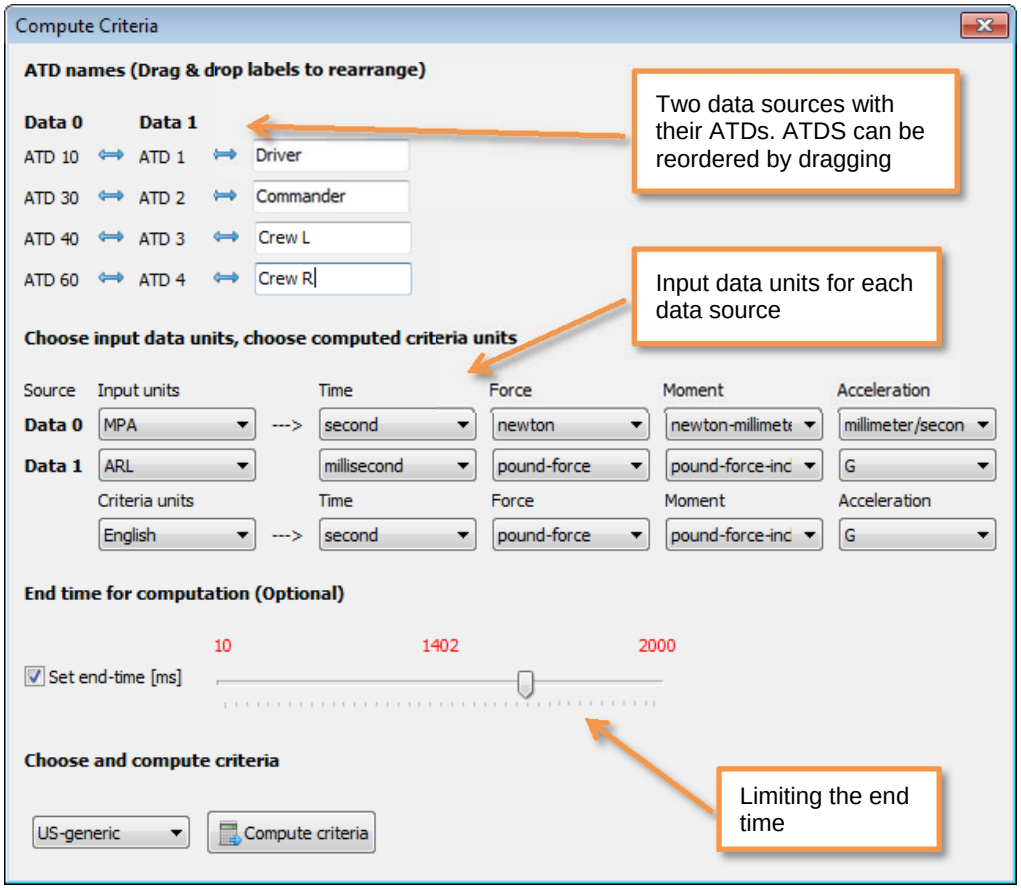

Figure 6: Criteria computation dialog for comparison between datasets

Figure 7: Comparison between simulation and test. Frames show compared ATDs

Conclusion

Using PC3 for criteria computation, comparisons between datasets (either from simulations or test) and for report generation greatly simplifies the workflow of post-processing, especially when a large number of ATDs are included in the data. Avoiding manual computation of the criterions, and instead relying on automated tool can simplify and speed-up the computation, while also avoiding manual computation errors.

References

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