Latest Developments in Crash Pre Processing and Post Processing - Innovative Ideas Brought to the Industry

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Abstract

The increasingly demanding and complex requirements in Crash Analysis, call for continuous and innovative software development. BETA CAE Systems in an effort to meet and exceed the requirements of the industry is introducing new cutting edge technologies, both in the pre-processing area with ANSA, and in post-processing with μETA. This paper presents these new technologies.

With the introduction of a new version of ANSA in 2009 a new user interface was presented. The new interface is a long-term effort to give the CAE engineer the capacity to work in a modern software interface environment leading in increased productivity and "ease-of-use". Taking the burden of the hard pre-processing tasks away, it allows the user to take full advantage of the solvers capabilities. The effort is ongoing and further enhancements and developments throughout 2010 and the 13.x versions will lead to a totally new user workflow.

At the same time, the development of highly specialized tools can greatly reduce the re- processing time by automating various difficult operations. A characteristic example is the introduction of an integrated multi-body solver that allows the manipulation of complex kinematic mechanisms of crash models (i.e. suspensions, seats, dummies, roof tops etc.). In the field of occupant and pedestrian safety, advanced tools that automate the procedures of target identification and impactor positioning allow the easy creation of corresponding load cases. Additionally, these tools give the possibility of further analysis types such as Robustness Analysis.

In the area of post-processing, the advances are equally impressive in the latest μETA versions. Better utilization of system resources, such as smaller memory footprint and a huge speedup in graphics performance, guarantee that the responsiveness and feel of the software environment won't be compromised even by the largest models. Additionally, advanced functionality, like the direct calculation of section forces, provides the tools that are needed for the evaluation of the results. Recently, process automation tools are introduced, which together with advanced report generation features make the automation of post-processing much easier.

Introduction

Recent developments in ANSA and μETA have introduced new powerful tools that allow the easy manipulation and management of LS-DYNA® FE models. This powerful core functionality together with new modern User Interface design creates a powerful and intuitive working environment. This paper introduces some of these new technologies that have been introduced by BETA CAE Systems SA.

Kinematics and Dummies

With the introduction of ANSA version 13.0 BETA CAE Systems has introduced a highly sophisticated set of tools that can handle any kind of positioning or articulation requirements of crash models. Taking into consideration the fact that in addition to dummies, suspensions, roofs and other subassemblies need to be repositioned, a multi body solver has been developed to be tightly integrated with the pre processor.

Dummy Positioning

The increased use of full FE dummy models in crash and safety simulations have triggered the development of advanced tools for easy handling and articulation of these models.

All “hierarchy tree” formats are supported including the old .tree LSTC format, PRIMER “*DUMMY_” keywords used by FTSS dummies as well as the new “occinfo” keywords used by newer LSTC dummies.

The dummy positioning tools in ANSA allow for translation and rotation of a dummy and rotation of its parts. These tools have been updated to allow even more complex movements. The movements can either by driven from a window interface or interactively from the screen by just clicking and dragging. Limbs can be moved not only as rigid bodies performing a single rotation, but can also perform multiple limb movements, at once, as the user defines interactively the final position of any point of the limb. The program calculates all the needed movements. Added options such as performing symmetrical movements (between the hands for example) are added in order to allow very fast and natural articulation of the dummy.

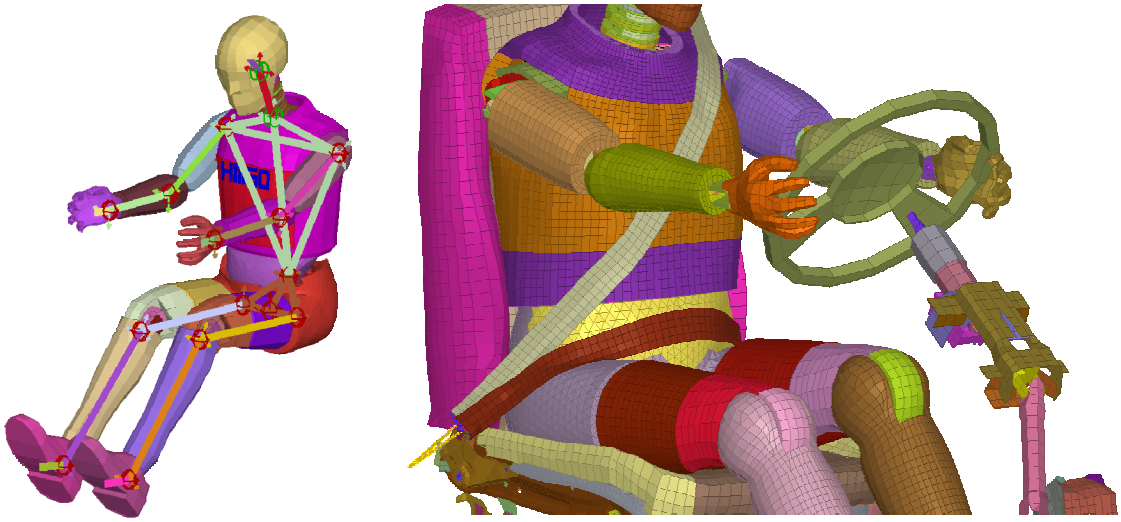

Figure 1. Dummy read into ANSA

Seatbelts

Seatbelt tools allow the creation of seatbelts. Advance fitting algorithms create seatbelts that have a natural fit around a dummy's torso. Support for 2d seatbelts utilizing shell elements through the sliprings has been added.

Kinematics Tool

With the introduction of ANSA version 13.0 BETA CAE Systems has introduced a highly sophisticated set of tools that can handle any kind of positioning or articulation requirements of crash models. Taking into consideration the fact that in addition to dummies, suspensions, roofs and other subassemblies need to be repositioned, a multi body solver has been developed to be tightly integrated with the pre processor.

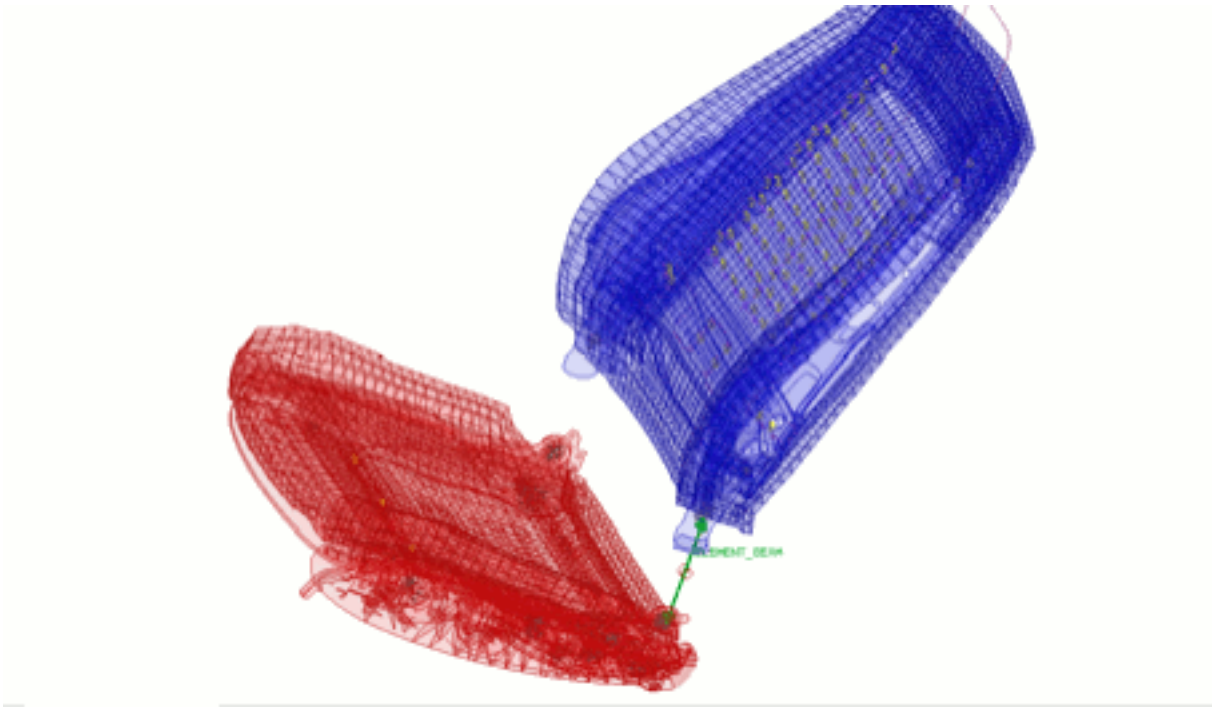

Figure 2. Automatic detection of kinematic subassemblies and joint elements.

Key features of the tool are:

- Functions that automatically, or semi automatically, helps the user to create the kinematic model from the existing LS_DYNA model.
- Information of the *CONSTRAINED_JOINT_ and CONSTRAINED_JOINT_STIFFNESS_ keywords like the high & low stop angles is transferred at the same time as constraints to the kinematic model.
- The multi body solver HHT-I3 supports all the standard joint types (spherical, hinge, cylindrical etc).
- Advanced joint types are available such as rack-pinion, point on curve and coupler joints that can model advanced mechanical or electronic couplings.

- The intuitive interface allows the organization of the kinematic components so, that different movement configurations can be predefined by the mechanism expert. Characteristic examples are the tilt and height adjustments of a seat model. This is important because not all users need to know all the details of the kinematic configuration but rather focus on positioning to them to the required position. For this job, the software provides an easy interface to move the model from these predefined configurations.
- Tight integration with other functionality already present in the preprocessor. Deformable parts connecting different parts of the kinematic model can be controlled and reshaped automatically by the morphing tool. Examples are stabilizing bars, springs, deformable ducts, stretchable fabric covers etc.
- All manipulation is performed automatically on the LS-DYNA model taking into account spatial information need to be transformed (PART_INERTIA cards, ELEMENT_DISCRETE offsets etc).
- Multiple positions can be saved, and the model repositioned in any later time.
- There is also the possibility to output only transformation information in the form of *NODE_TRANSFORM cards adding the ability to treat validated models as read only files, and thus ensuring the robustness of the process.

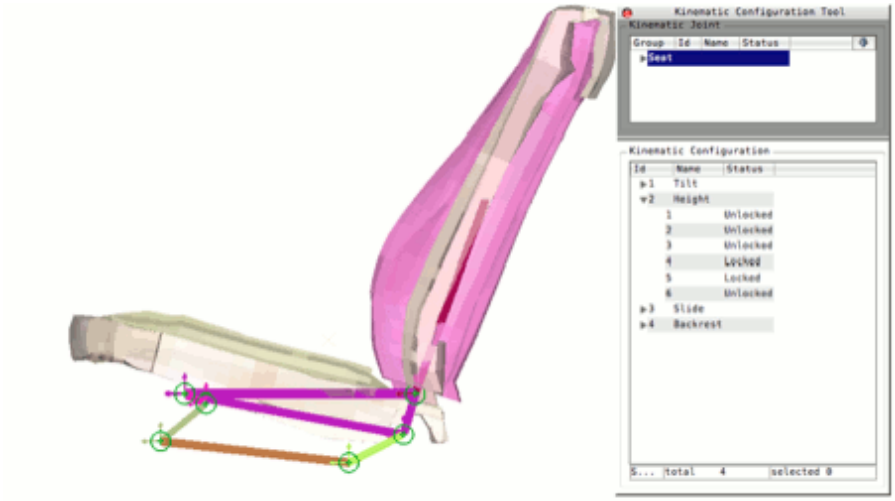

Figure 3. Example of a complete seat configuration setup using the ANSA kinematic tool

Pedestrian Protection

In version 13.x new functionality has been introduced that automatically applies the regulation directives to identify the target areas and target points. The latest EuroNCAP pedestrian testing protocol as well as the EU Phase 1 and Phase 2 (also known as GTR) have been implemented in the Pedestrian Tool. Bumper and bonnet reference lines are automatically calculated on the FE-model, or on Geometry data, closely following the regulation procedure. The ability to operate on Geometry data is especially useful for evaluation of the design in the concept phase. The Adult and Child Head form zones are defined and divided into the twelve areas. Moreover, user created curves can overwrite the curves that represent the reference lines. Thus the user can intervene in the process if it is needed.

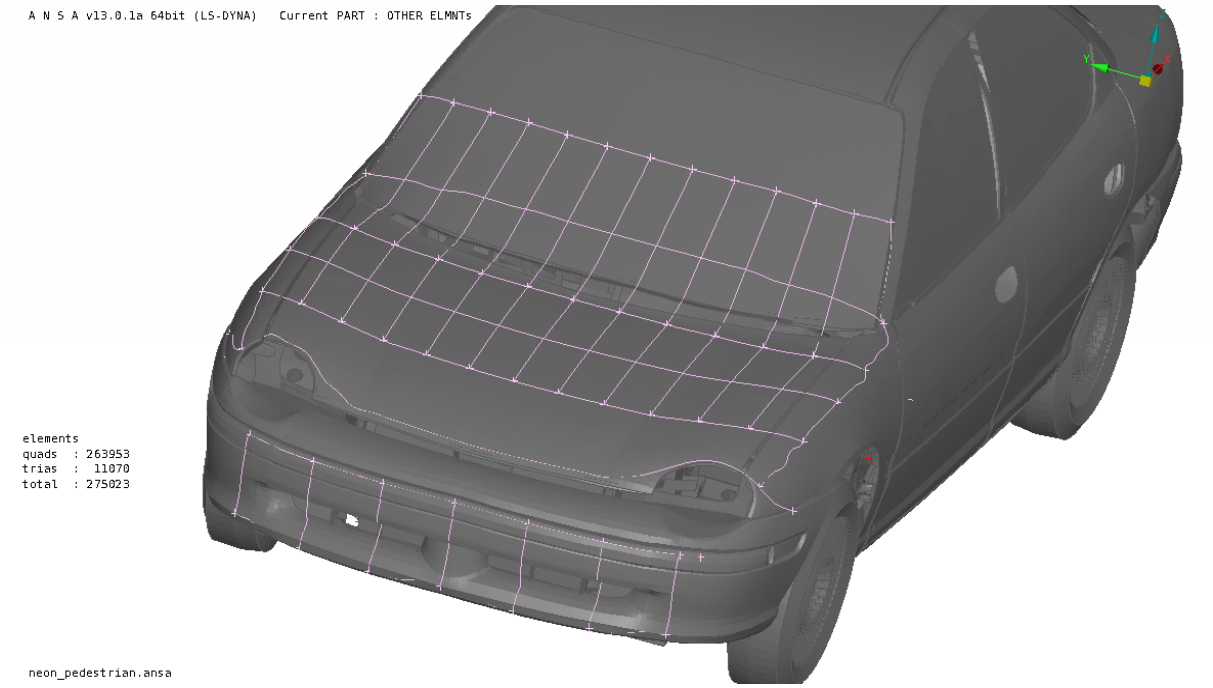

Figure 4. EuroNCAP references lines automatically created

For the identification of the target points the user has two options. Either create a uniform raster of user-defined dimensions or detect a user-defined number of the worst-case target points per area. This is achieved by scanning each area for the points with the least distance between the top bonnet surface and the underlying hard parts in the shot's direction.

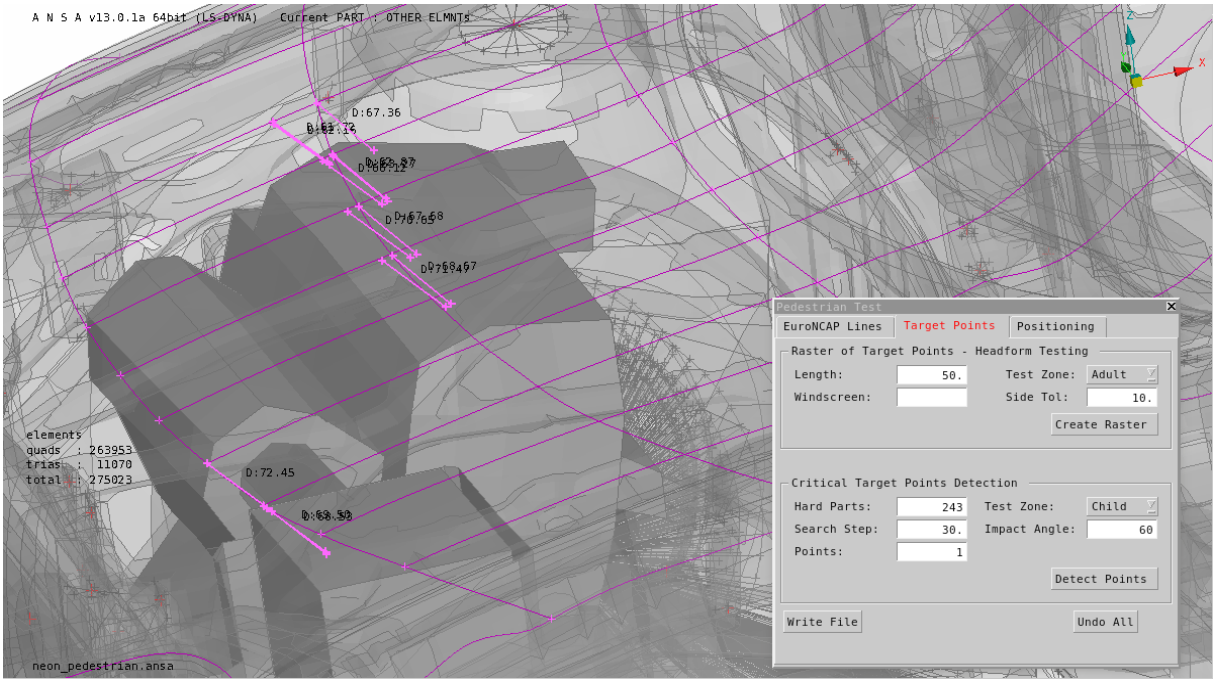

Figure 5. Pedestrian Tool: Critical target point detection by taking hard parts into account

Following the definition of the target points, the positioning takes place and produces the respective LS-DYNA transformation keywords that define each load case.

Interior Protection

For the FMVSS201 U test protocol a new tool that covers the whole procedure was developed. All the protocol procedures are replicated creating the appropriate planes and curves so that the target points are identified.
Positioning is done automatically taking into account Horizontal/Vertical angle limits as well as the rebound angle of the free motion head form. The positioning procedure itself is performed with a contact based algorithm that guaranties the quality of the final positioning. Powerful manual positioning functionality is also available for the experienced user.

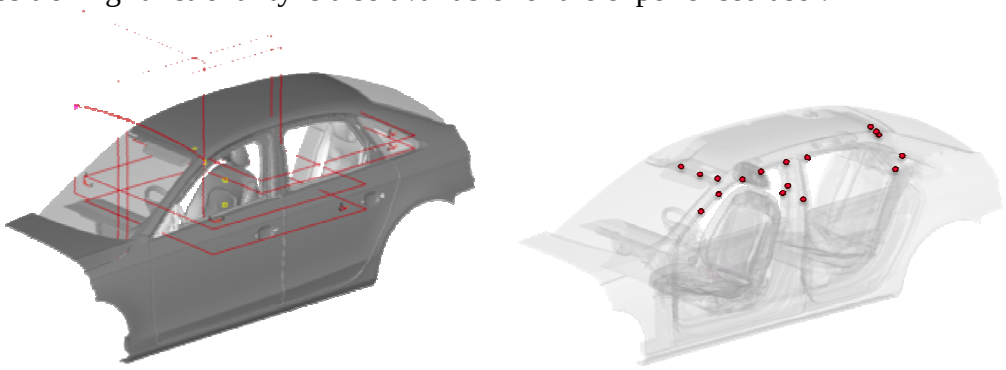

Figure 6. Automatic planes and target points definitions

Moreover algorithm performing robustness and sensitivity analysis are being developed that will provide an easy way for the engineer to evaluate the validity of the analysis and design.

A positioning tool is also provided for the ECE R21 (Pendulum) protocol.

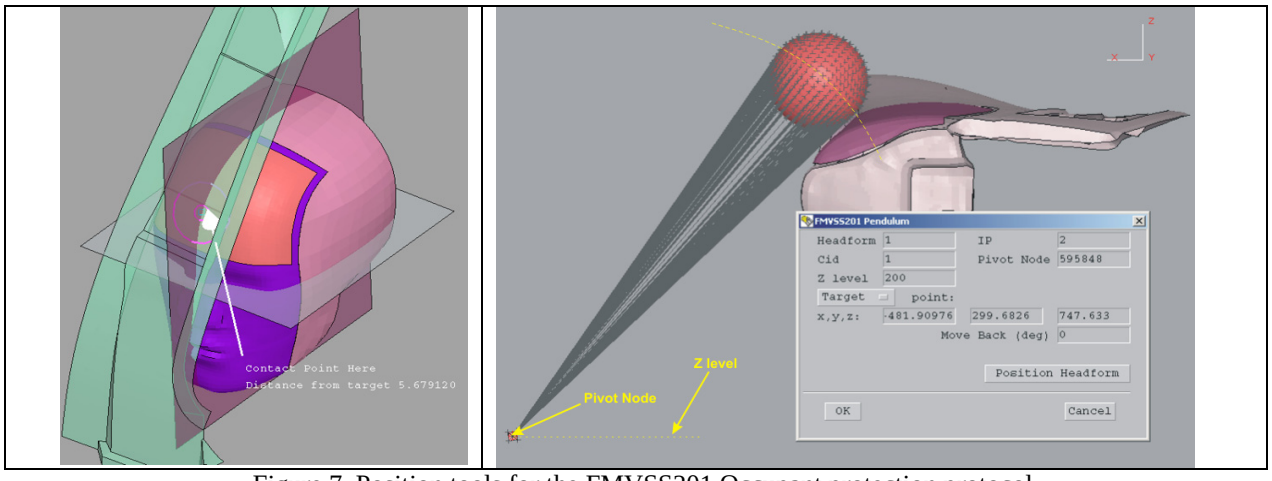

Figure 7. Position tools for the FMVSS201 Occupant protection protocol

Includes

ANSA offers various navigation methods over an FE-model. One of these navigators, called the Includes Manager, is capable of handling; creating and managing include file definitions in a tree-like manner. It empowers the user to have a full control over the FE-keyword's id ranges, in order to satisfy numbering schemes of complete structures. Model modifications and changes can be performed so, that newly create FE-entities should be directly inserted to a certain include file definition.

GUI

The management of huge amount of data requires that the software have the right tools that are easy to use and can provide the user with relevant information fast. As of ANSA v13.0 a big effort has began for the overhaul of the ANSA user interface. The reason for this move was necessary in order to meet the current standards of Graphical User Interface design.

Most of the advanced CAE pre processors, and other CAE software, have their design roots in the late 80s and early 90s. This is evident to anyone who is working in the CAE field. While through out these years a strong effort has been put in the development of powerful algorithms, which is the main field where big time savings can be achieved, the user interface has been neglected. This practice has started to show its shortcomings, as CAE becomes mainstream and more and more new engineers work in the field. Young engineers that have experience with other kinds of software like office productivity suites, the modern UIs of operating systems and web environments find it hard to learn and adapt to the archaic and outdated idioms of the CAE programs. This results in great loss of productivity and inability to adapt to new tools and processes. Another fact that puts a lot of pressure on the interface design is the rapid rise of the model complexity. The CAE user faces a huge task, which is to deal with this complexity. It's the goal of modern User Interface to relieve the user of this burden.

It is apparent that Modern User Interface alone cannot meet the challenges of the CAE pre processing. User Interface design, in order to be meaningful, always needs to be on top of smart and powerful algorithms which is the core of CAE. The new user interface allows for easier implementation of advanced functionality and gives the ability for fast learning for new users.

Having the above in mind, new tools have been designed and introduced in ANSA. These changes will be deployed progressively throughout the v13.x series of ANSA.

Model Browsing

Model browsing is done with the help of the Model browser, which is the central information centre of the program. The model browser is a unified single browser for all the entities in a model (including geometric entities). The user can control everything from the visibility of entities, to accessing the entities' cards, to creating new entities and many more.

Its structure and look is that of a hierarchical tree list accompanied by the expanded list of the selected item. Various interface elements like history; search, context menus (right mouse click menus) etc have been implemented to add functionality. These are creating a familiar working

environment to users since these concepts are widely used in today's software applications (file managers, mailers, web browsers, etc). This leads to uniformity and reduced training time for the users to become productive. Nevertheless various additions and extensions have been implemented to better handle CAE workflow.

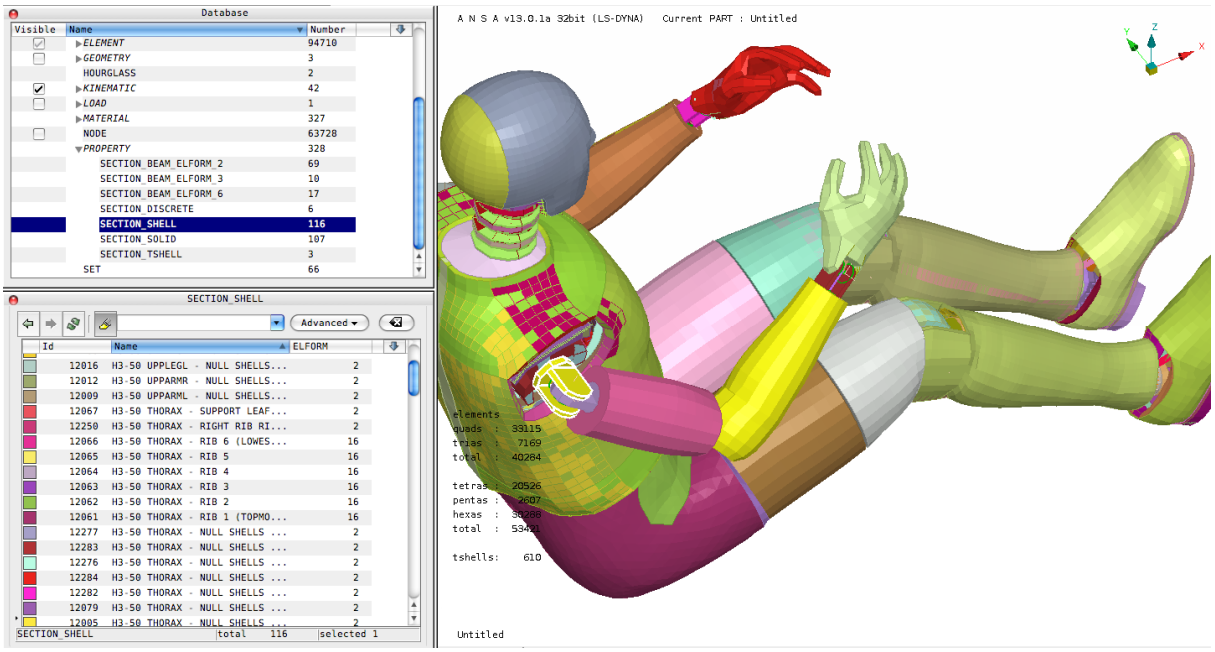

Figure 8. Model Browser

Filters

As the user builds confidence using the tool the tool itself scales up nicely providing advanced functionality. One such functionality is the concept of filters. Filters are used to search easily and select model entities based on various attributes. More importantly filters can be saved and used as dynamical updated smart containers of entities.

Drag 'n' Drop

Another common idiom that has been imported is that of drag and drop. The user has the ability to select entities from the browser (or the screen) and drag and drop to other objects to create new entities such as includes, SETs etc. This functionality together with the advanced selection and filtering option give the ability to work in a very friendly and intuitive environment. This environment allows the set up of complex entities like *SET_GENERAL and *SET_*_ADD in ANSA v13.x to be a pleasant experience.

Dynamic Draw

Another area of great importance for the model comprehension and handling is the drawing of the various entities on the graphics screen. Through the graphics display the program communicates with the user and helps him understand the model and interact with it.

Unfortunately the complexity and size of modern models lead to graphics clutter, information overload along with program unresponsiveness.

Various new technologies have been designed and implemented to address these issues.

Detail on Demand

With the introduction of the "Detail on Demand" concept the graphic representation of the various model entities is dynamic and follows the user workflow. The most basic and notable change is that elements that are not in the user field of interest are drawn with reduced detail. The screen clutter is strongly reduced while at the same time more information is provided in the area of interest. The end result is a much clearer view of the model, more valuable information provided automatically and fewer user clicks.

Transparency Pick

On the same line of thought a second concept was developed that helps the user when performing any action that requires selection from the screen. In order to unclutter the display only the elements that are relevant to that action being performed remain visible, while the rest become transparent and dimmed. So while they don't obscure the picking process at the same time the user remains well oriented in the model.

Latest Post-Processing Developments

Performance

µETA v6.3 contains significant performance improvements that are summarized in the following figure.

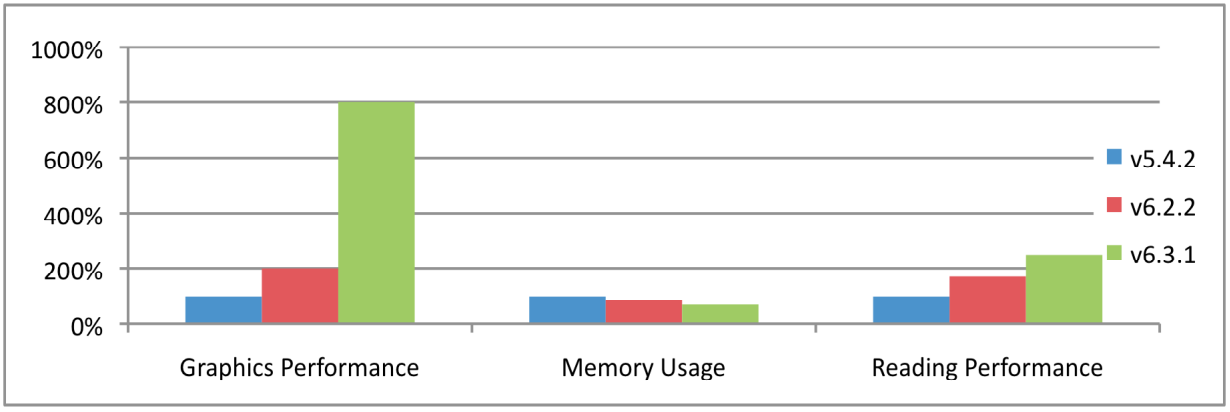

Figure 9. Performance improvements

Memory Improvement

In version 6.3.0 a 25% reduction in memory requirements compared to past version has been achieved. Also the 64 bit version has smaller memory footprint.

Graphics Improvements

A new algorithm has been introduced that improves drawing performance significantly. A speedup factor of 2 to 8 is expected depending on the graphics card of the machine. This speedup is even higher in contour plots and fringe plots.

Computational Speed

The latest versions includes optimization of the code for multi-core system. This reduces computation time for intensive operations like section forces calculation, reading geometry and results, evaluating user field functions, etc.

Reading Results

The reading speed of the software is improved for all types of results. Additional method for reading femzip compressed d3plots on the fly, without decompressing first on the disk. This reduces also the maximum memory requirements during decompression and improves performance in case the user wants to load only a subset of d3plot states.

Section Forces Calculation

The calculation of section forces is an important aspect throughout the design cycle of a structure. However, section forces must be predefined in the input deck, thus making unavoidable a second run in case it turns out that it is needed to investigate the force distribution in arbitrary areas of the structure. The section forces tool in μETA is capable to compute forces and moments at any section defined by the user or predefined in the input deck, achieving very good correlation with the solver calculated results.

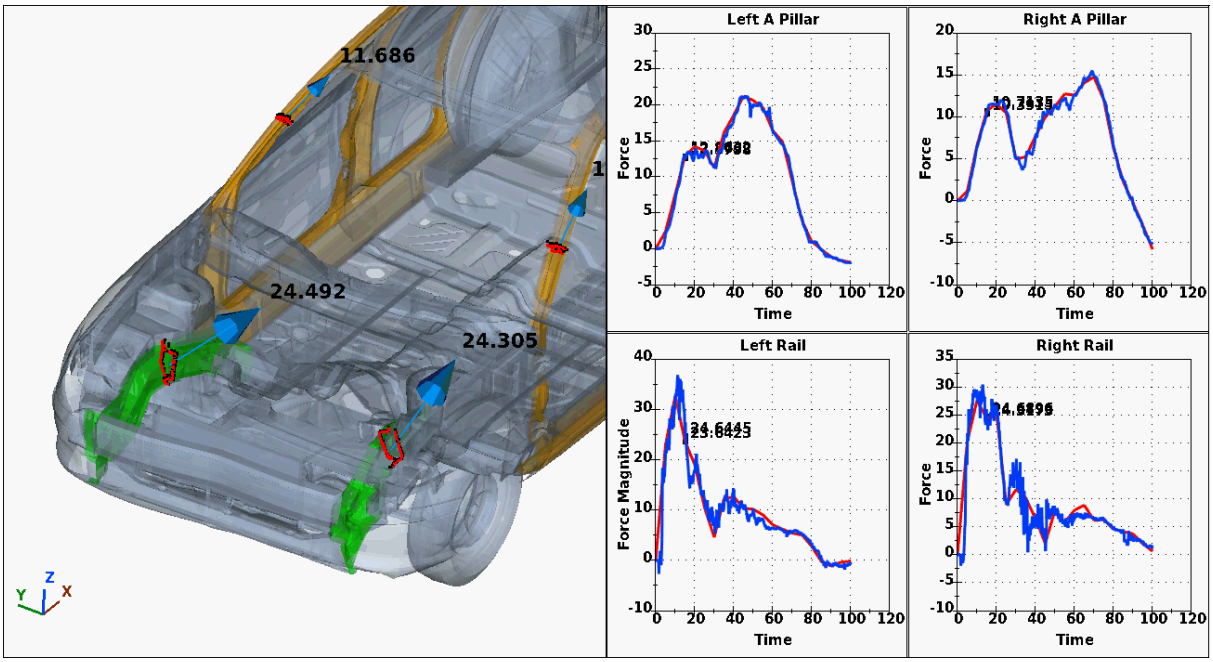

Figure 10. μETA calculated section forces compared to LS-DYNA

Report in PowerPoint pptx

The new report composer tool allows the user to create a pptx report effortlessly, with PowerPoint like functionality including Slide Master creation, Themes templates and drag & drop handling of objects. It is also possible to read and edit an existing pptx report, as well as to embed μETA viewer objects that include a 3d model or 2d plots that the user can handle interactively.

Additionally the Copy/Paste functionality to Clipboard helps users to easily transfer images and data from μETA to other software.

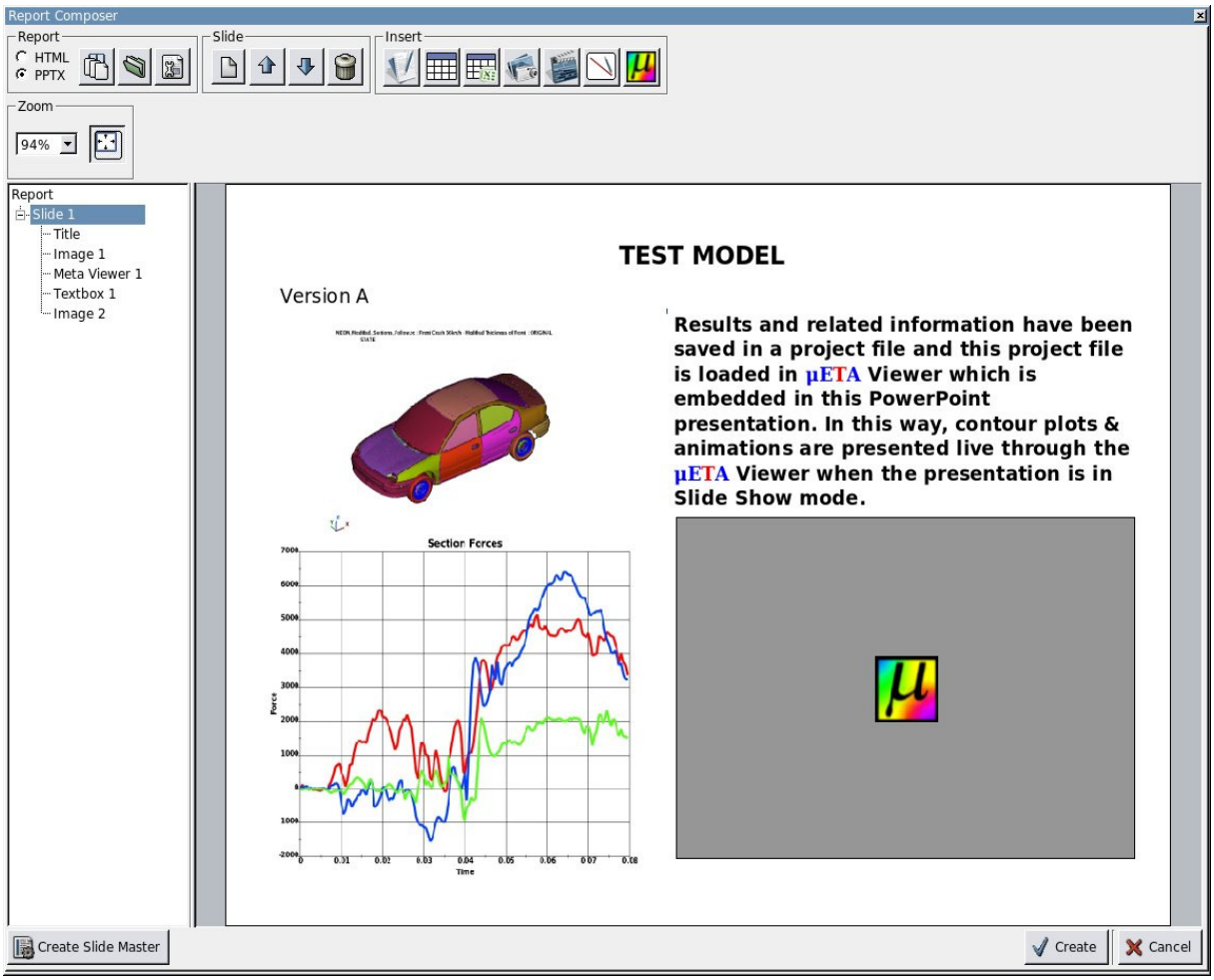

Figure 11. μETA Report Composer

Automation

The automation toolset of μETA is enriched with the recent process automation tools. The session editor with the advanced session parameterization tools, the debugging capabilities, easy creation of toolbars and the compressed package creation manager, facilitates automation. BETA scripting language and the embedded script editor offers enhanced flexibility and elevates the automation capabilities of μETA to a far greater extend.

Compression of Simulation Results

A New capability will be added in v7.0 for data compression of simulation results. Apart from a standard gzip-like file compression, the size of result files is further decreased through the option to keep only necessary variables and up to the necessary level of accuracy, achieving high compression ratios (original/compressed size > 10). This technology will reduce storage requirements for huge models, but also will improve loading performance since smaller files needs to be transfer through network.

Conclusions

Simulation and CAE in the recent years has become mainstream and a mature technological field. BETA CAE Systems heavily invests in order to offer the best possible software products both in its core functionalities and algorithms, as well as in Usability.

References

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