

The use of Generic Entities for Multidisciplinary preprocessing. A simple but powerful pattern in ANSA

Yianni Kolokythas, Lambros Rorris
BETA CAE Systems SA, Thessaloniki, Greece

Abstract

Today's multidisciplinary CAE environment demands for rapid FE Model development cycles, thus the efficient processing of repetitive and complex modeling tasks is vital. This creates a need for highly automated processing steps and effective data sharing between the different CAE disciplines.

BETA CAE Systems SA, in order to meet the above requirement, came up with a series of technologies, integrated within its preprocessor ANSA. These technologies allow the handling of the preprocessing environment in the engineering entities level rather in the solver entities level, making possible the treatment of model data as generic engineering data and not as specific FE solver entities.

For simple tasks, such as the spotweld connection modeling, to more complex ones, such as a seatbelt or that of a stamping result mapping, there are ANSA entities that hold all the engineering data needed for its realization to the respective e.g. LS-DYNA entities. All the different types of those Generic Entities are similar in their definition and realization. At realization time the generalized entities, automatically adapt to the solver-specific FE (e.g. LS-DYNA). Thus making it straightforward to master the ANSA model-build-up capabilities and share and re-use the engineering data among different disciplines.

This technology essentially creates a single, generic, pattern that is re-used throughout ANSA modeling tasks. This pattern driven technology provides a very practical and powerful solution for recurring modeling processes where the engineering data and the solver's data are kept separately, and associated as required.

This paper on ANSA's Generic Entities presents the latest advances in model build-up technologies in the specific areas of connections and connectors, mass trimming, results mapping, dummy positioning and restraining, pedestrian and FMVSS 201U model set-up. As it is demonstrated, the exploitation of this modeling approach makes the LS-DYNA model built up process more time, effort and cost efficient.

Introduction

The problem

The CAE model built up is a complex time consuming operation. A great part of the work involved in building a CAE model is the repetitive modeling tasks, the organization of the data and the keyword definition per the solvers technical requirements. Therefore this puts a big burden on the CAE engineer and on the entire process. The CAE engineer should have the tools to concentrate more on the engineering aspect of the modeling and less on the keyword definition.

The Solution

BETA CAE Systems a few years ago developed the notion of Generic Entities, which minimize the user's involvement with the solver implementation details. The Generic Entities work as abstraction layers between the engineering info/data and the actual solver keyword implementation/representation. The engineering information they hold are:

- Where to apply. The xyz location in space
- How to apply. The orientation of the representation and what the search needs to look for (bolt hole, nodes etc).
- What to apply. What type of representation will be created

The pre-processor knowing this information can do the rest of the job. Upon the application of the Generic Entities, the pre-processor creates everything that is needed for proper FE representation. That is the solver keywords such as sets, elements, constrains, boundaries etc.

A very important capability of using Generic Entities is that they can easily be re-applied during model variation studies and can be shared between different engineering disciplines, because the engineering data is the same.

Having this type of approach in pre-processing, it will be shown that a pattern emerges that can work in anything, from a simple spotweld to a complex occupant seatbelt. In this paper the notion of Generic Entities is explained and it is used to explore advance functionality of the ANSA pre-processor.

Simple Patterns

Connections

A spotweld is a representation that involves multiple solver keywords. For example a LS-DYNA spotweld, needs solid elements, contact definitions, SETs, a property and a material definition.

This process would take long time to be performed manually. In order to be able to handle the creation and the management of spotwelds, Connections entities are used. The Connections entities are ANSA entities that hold the engineering information of the spotweld. This information is the x, y, z location in space, what is connects and what type of FE representation does the user for the specific solver or analysis require. ANSA will automatically apply the desired representation and create all the necessary solver keywords.

Similar is the approach with connection lines. A connection line entity holds all the necessary engineering info, and ANSA automatically creates the necessary LS-DYNA keywords.

Connectors

Connectors are ANSA entities, used to connect two or more sub-assemblies or parts together, modeling the kinematic constraints that physically exist between them. The representation of the kinematic constrained can be any custom representation. The user can create a library item with a custom representation that can be called and applied from the Connector Entity.

Some of the automations of the connector entities in LS-DYNA are:

- The Connector Entities are defined using mesh density independent patterns for the identification of the connected entities. Thus, a connector can be applied on a hole, circular feature or a certain number of nodes or elements, in a pre-defined search domain.
- Connector Entities that connect a rigid with a deformable component with rigid interface automatically detect the case and create *CONSTRAINED_EXTRA_NODE instead of *CONSTRAINED_NODAL_RIGID_BODY entities.
- Connector Entities that connect rigid components together with rigid interface, automatically detect the case and create *CONSTRAINED_RIGID_BODY entities.
- The Connector Entities can use the built-in representations (i.e. revolute and spherical joints) or custom made ones, retrieved as templates from ANSA DM libraries. LS DYNA deck card values of the library items can also be parameterized so that they can be editable during the set-up of the connector.

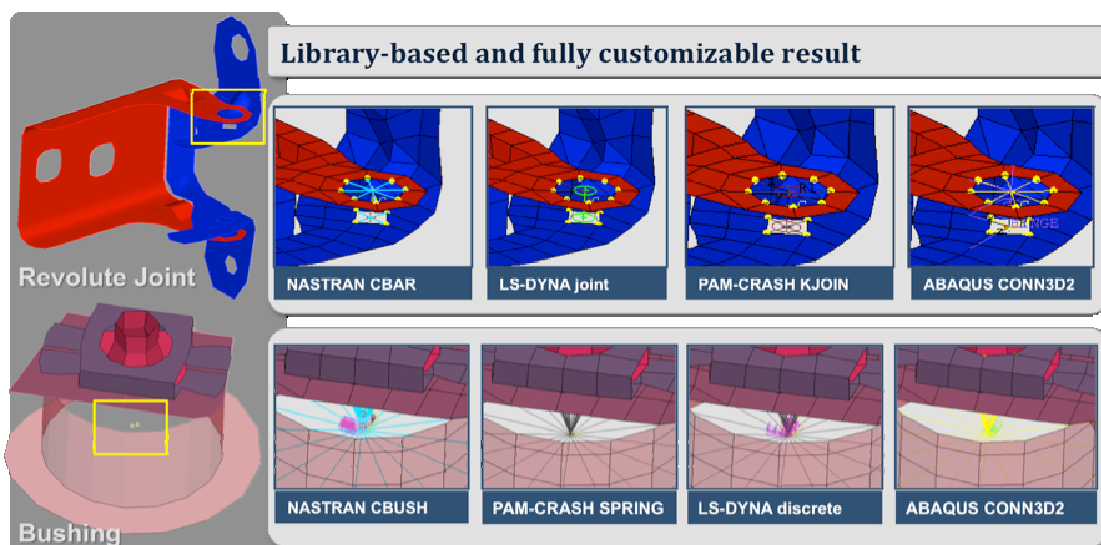


Figure 1. A Connector Entity applied for different solvers. The Engineering information is common all the cases.

Mass Trimming, Boundary Conditions and Output requests

Similar approach can be used to apply mass trimmings. With the concept of Where-How-What, generic entities are created with all the needed information to apply Masses, Boundary Conditions and Output Requests such as *DATABASE_CROSS_SECTION and *DATABASE_HISTORY.

These generic entities provide, the user, with a rich selection of search options, as seen on the image below. These searches options cover even the most demanding application.

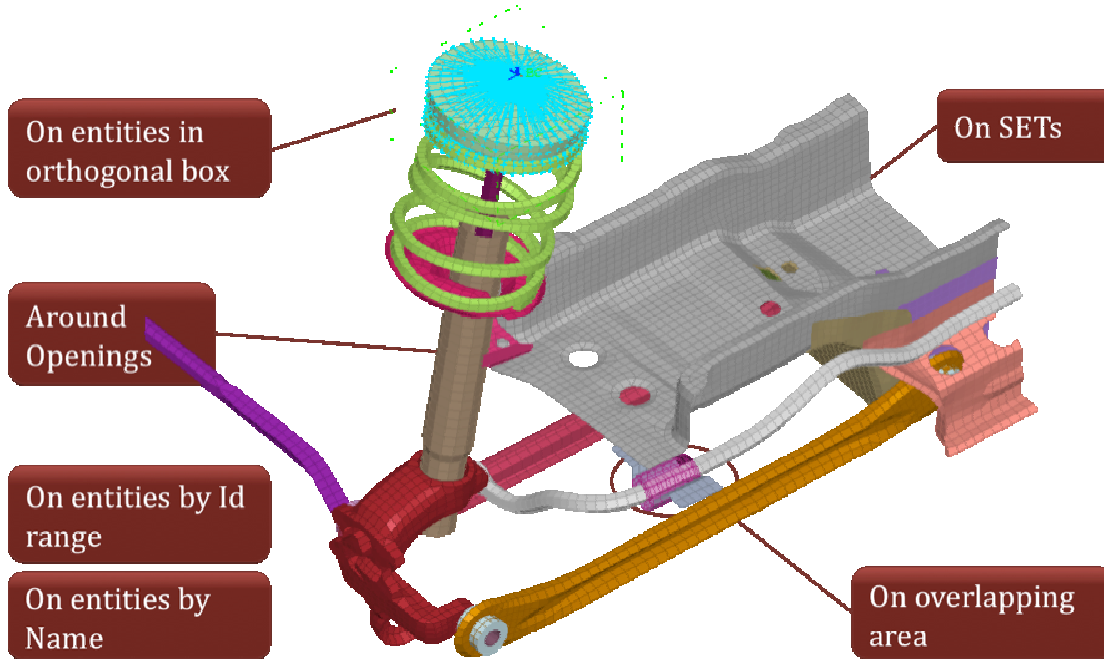


Figure 2. Search Methods for Connectors, Mass Trimming, Boundary Conditions and Output Requests

Mass Trimming

Several parts in a FE Model are represented as distributed non-structural or lumped masses. The process of mass trimming can be time consuming and complex. The General Entities provide ways to easily apply the desired type of masses in using the search methods described above.

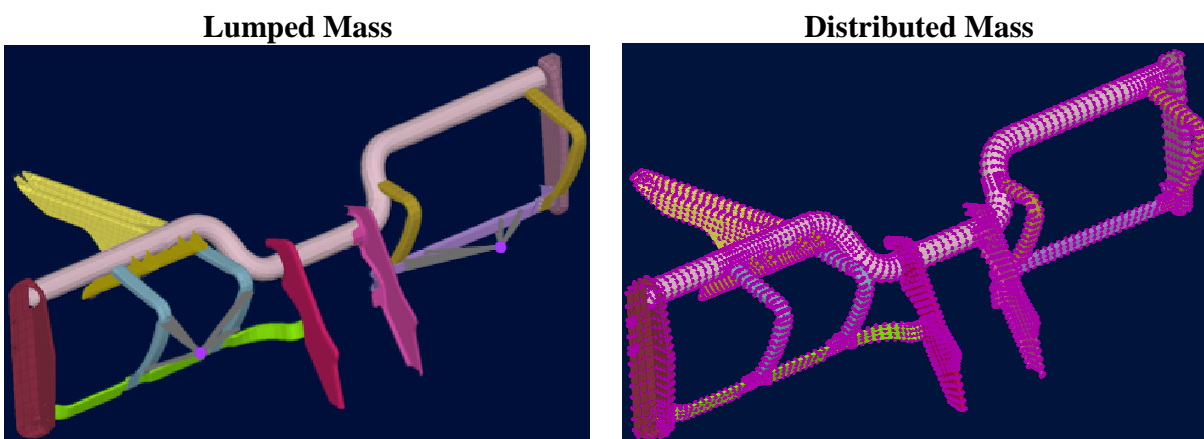


Figure 3. General Entities can cover all the cases of lumped and distributed non-structural mass creation

Output Request

The General Entities provide for ways to easily request analysis attributes, necessary for the post-processing. Such requests can be *DATABASE_CROSS_SECTION, *DATABASE_HISTORY, the positioning of accelerometer elements etc

Boundary Condition

The General Entities also provide for ways to apply constrains or loads on areas detected by the search methods described above.

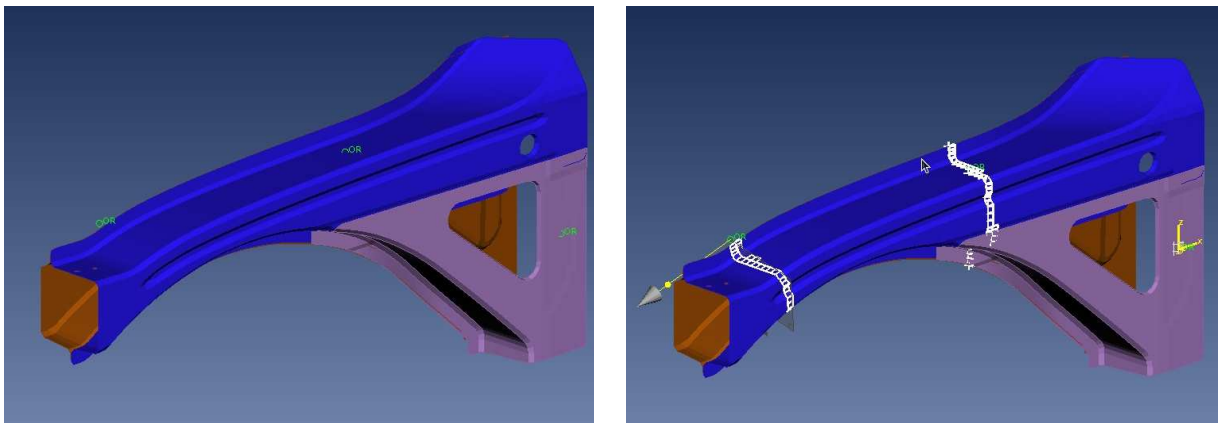


Figure 4. Generic Entities that create *DATABASE_CROSS_SECTION and apply a custom-made accelerometer

More Complex Patterns

Results Mapping

When aiming towards more realistic simulations, one analysis needs to use the results of a previous simulation as initial conditions. Such cases include transfer of physical data like nodal thicknesses, stresses and strains, material properties, and loads like pressures and temperatures. The “Results Mapping” functionality, offers a seamless way of integrating the transfer of results among standardized analysis types. The available functionality covers a wide range of applications, from mapping of Stamping Results to a Crash Analysis, to mapping of Pressure/Temperature distributions on a structural model.

The concept of where-how-what also applies in Results Mapping. Setting up the basic engineering information, ANSA will automatically apply the needed changes.

Within the preprocessor, the engineer can setup the exchange process of results among different solvers. The mapping, by default, takes into account the difference in meshes between the source data and the target model. Also, it considers changes in material orientations, converts scalar and tensor results, while taking into account changes in integration rules, sections and element orientations.

In the special case of mapping stamping results, the process can - almost always - automatically match and position parts that are designed in different coordinate systems. Also, it handles the mesh changes introduced by the adaptive re-meshing and addresses situations where mapping may locally fail. Most stamping and crash formats along with their results are supported.

Once the mapping process has been setup once, the software takes care of reapplying the source results on demand, when a change occurs. This allows the build of an accurate model of standardized quality. The user with topological criteria can also validate the final result.

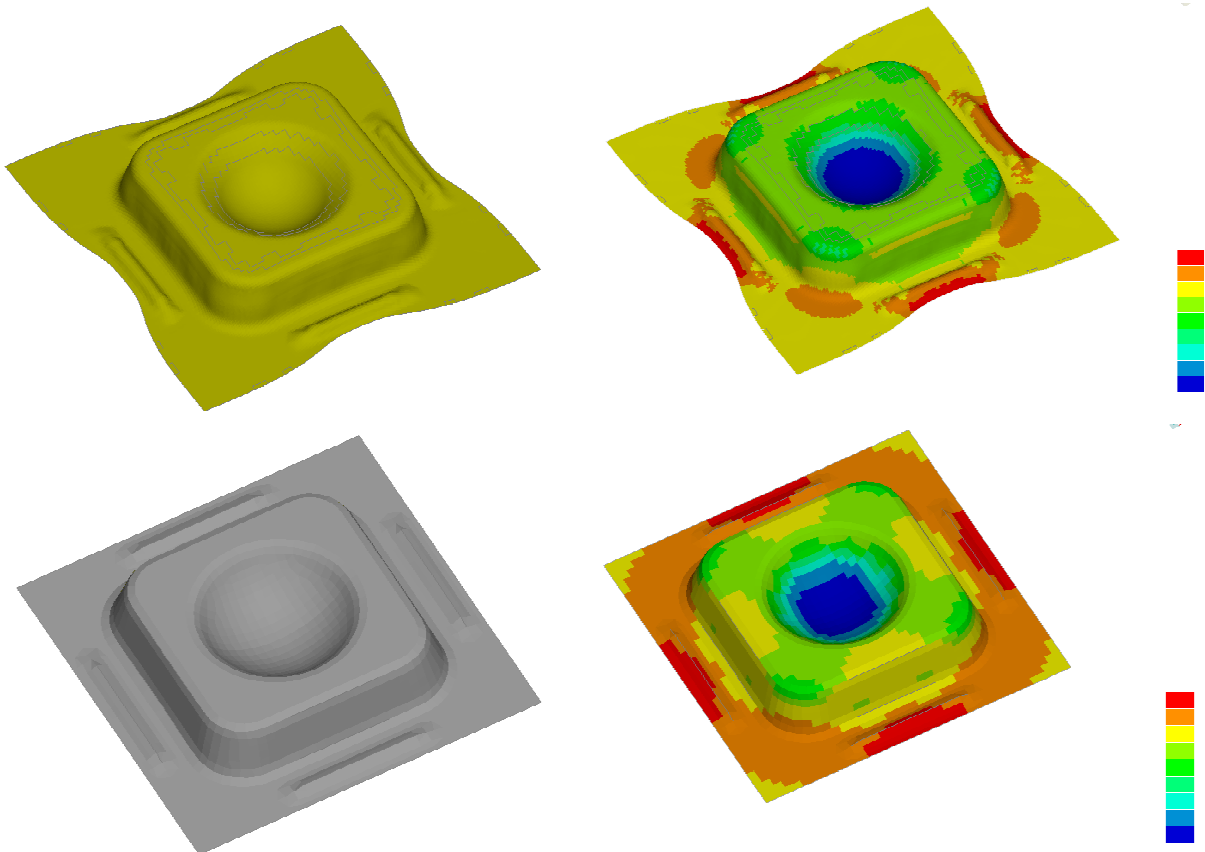


Figure 5. On top the stamping results are shown. Below the stamping results is mapped on the crash analysis part.

Seatbelts

The seatbelt tool, in ANSA, follows the same pattern that has been described through out the paper. The user provides the engineering information such as the path of the seatbelt, the anchor points, and the type of seatbelt. ANSA creates automatically the seatbelt with all the required LS-DYNA keywords.

A new re-designed seatbelt was recently introduced. Some of the characteristic features of the tool are:

- Although the option to create both 1D and 2D seatbelts existed for years the new tool can also route 2D seatbelts through slippings taking advantage of the newly introduced LS-DYNA keywords.

- The full support of LS-DYNA 2D *ELEMENT_SEATBELT keyword and the automatic creation of needed deck set-up with the appropriate SETS, material and property cards.
- Ability to interactively edit the path of the seatbelt to improve belt quality end meet the user's liking. The seatbelt slides on the dummy's surface in real time following the mouse movements.
- Seatbelts are ANSA entities. The information that is needed to create a seatbelt is stored and its re-application is seamless.
- Ability to automatically create all the peripheral elements that complete the definition of a seatbelt system such as slings, retractor, pretensioners, contacts between seatbelt and dummy etc. Thus the whole seatbelt system configuration can be saved, applied and re-applied for different positions or load cases.

The seatbelt information is written out in the deck output files as ANSA Comments. When a deck file is read back into ANSA, all the necessary information is there for tool to easily edit the seatbelts using the seatbelt tool.

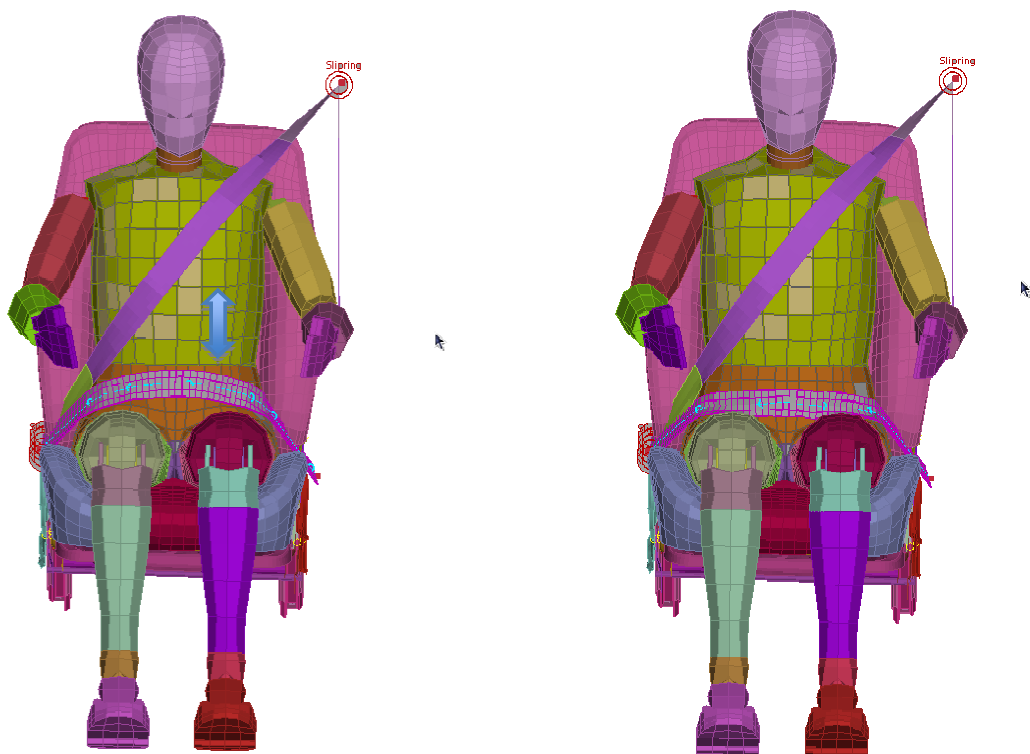


Figure 6. Real-time interactive edit of the seatbelt's path

Interior and Pedestrian Safety

Pedestrian Safety

The Pedestrian Safety tool in ANSA automatically applies the regulation directives to identify the target areas and target points. The latest EuroNCAP pedestrian testing protocol, the EU Phase

1 and Phase 2 (also known as GTR), JNCAP, TRIAS63 as well as the latest Grids Proposal of 2010 have been implemented in the Pedestrian Tool. Test procedures with headform and legform impactors can be set up. 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. The users are also given the ability to apply single and multi positioning to the identified critical positions producing output files ready to be solved.

The tool automatically creates ANSA Entities called Target points. A target point holds the engineering information of the impact. Such as position, impact angle, impact velocity, move back distance etc. This information is stored and can be re-used to easily re-position the headform to the desired position or to massively position and output include files for every target point.

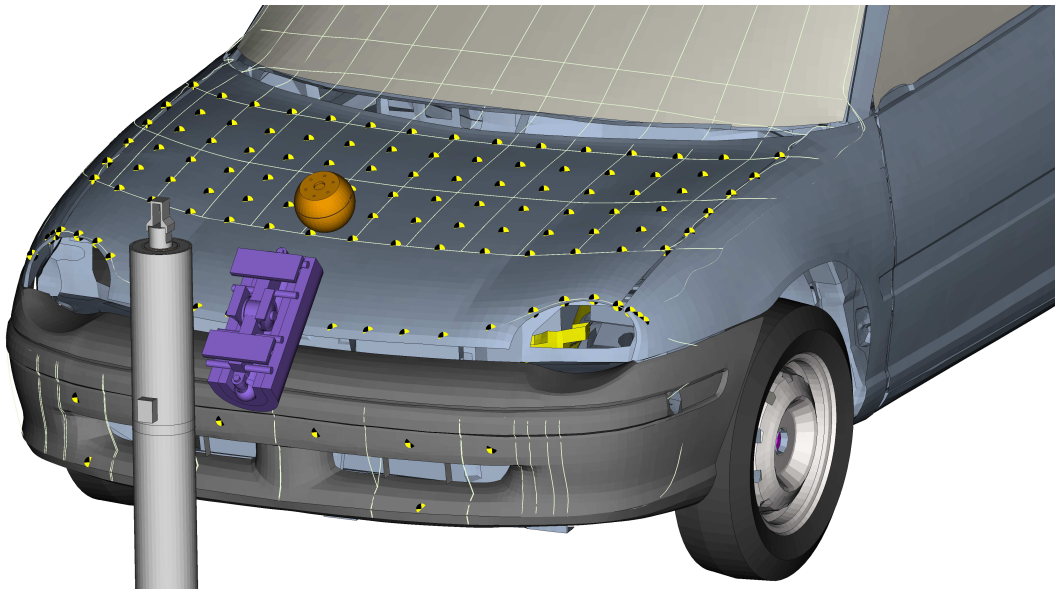


Figure 7. The ANSA Pedestrian Safety Tool. The yellow and black colored points the ANSA Target Point Entities

Interior Safety

For the FMVSS201 U test protocol ANSA's covers the whole regulatory procedure. All the appropriate planes and curves are replicated and 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 headform. 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.

As was described in the Pedestrian Safety tool, Target Point ANSA Entities are created for every target point with all the engineering information for the particular impact. This information includes the location in space the vertical and horizontal angles, rebound angle, impact velocity etc. The user has this information available in order to easily reposition the headform without the need to recalculate.

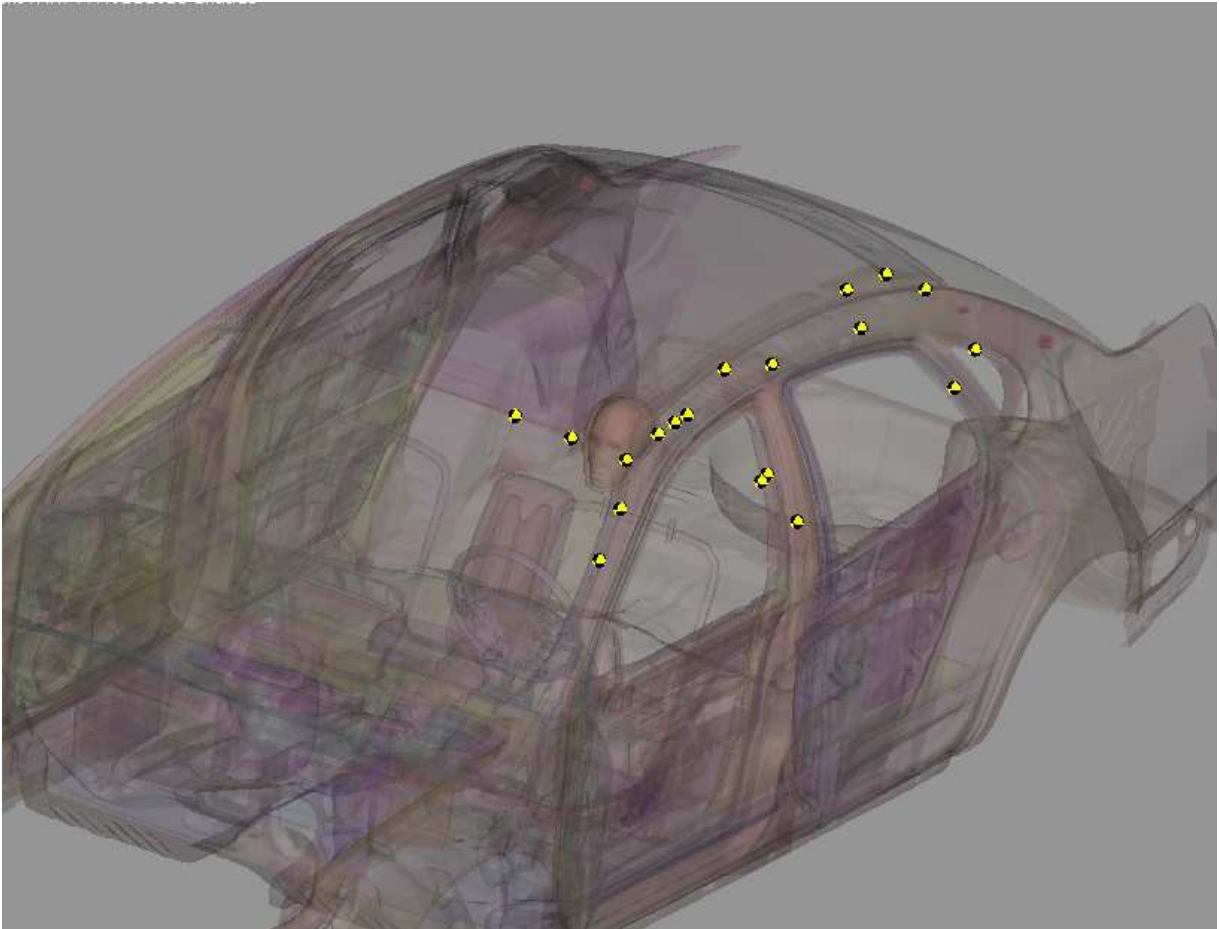


Figure 8. The ANSA Interior Safety tool. The yellow and black colored points the ANSA Target Point Entities

Conclusion

The Generic Entity driven pre-processing provides the user and the CAE process with a lot of advantages. Working as an abstraction layer, the Generic Entities allow the user to work in the engineering level, while ANSA manages and creates the LS-DYNA specific keywords. The data that is stored in the entities also allow for instant re-creation of the data during the design changes and model updates. Lastly the due to the fact that the engineering information is common the Generic Entity Information can be shared among the different CAE disciplines or teams.

Examining all the different functionality that the Generic Entity Concept is used it is observed that although they are different modeling procedures, a pattern emerges where essentially the required information is the where-who-how. This concept greatly assists the user in the complex world of CAE.

References

1. ANSA version 13.0.1 User's Guide, BETA CAE Systems S.A., February 2011
2. Makropoulou I., Kolokythas Y., Rorris L., "LS-DYNA Impact Model Build Up: Process Automation with ANSA Data Manager and Task Manager", 10th International LS-DYNA User's Conference, Detroit, USA, June 2008
3. Seitani s., Giannakidis M., "Definition and Parameterization of a Task Manager Process Workflow, Applied on the Generation of an ABAQUS Loadcase", 2nd International ANSA and μ ETA Congress, Halkidiki, Greece, 2007
4. LS-DYNA Keywords User's manual. Version 971 R5, Livermore Software Technology Corporation, Livermore, May 2010.