Automatic Barrier Positioning for various regulations enhancing CAE productivity

Michael Sommer (Dipl.-Ing.) ESI GmbH,

Ganesh Kini (B.E) ESI Software India, Malathi Palaniswami (M. tech) ESI Software India

Engineering System International GmbH
Mergenthalerallee 15-21
65760 Eschborn
GERMANY
Email: info@esigmbh.de
URL: www.esi-group.com

1 Preamble

Each day many drivers and passengers die due to car accidents. The risk of death is higher or lower depending on the car and even further on the car model. Vehicle models differ widely in many ways; with respect to safety ranking values large cars like minivans, SUV, pickup tracks compete smaller and midsize cars.

The most important characteristics of vehicles influencing injury rates are vehicle design, size, weight and the combination of different restraint systems. Among these physical criteria national organizations for automotive safety define local requirements for their legal regulations varying from region to region. The NHTSA (National Highway Traffic Safety Administration) regulates requirements for the US market whereas the European automobile manufacturers have to follow the EuroNCAP regulations. Worldwide safety organizations create their local regulations based on regional driver behavior and geographical conditions.

European car customers are very much aware of the meaning of safety applications in cars. Vehicle safety became a more and more important factor within the purchase decision process of end customers, who appreciate buying cars with top ranking results for the car' safety features.
Thus given, any publication of EuroNCAP testing results and the related result comparison of various vehicle models and their performance play a major role for the OEM'S to market their cars. Even the immediate selling success depends strongly on the car's safety results based on the regulations of the various regulatory boards.

Releasing vehicles satisfying safety requirements in all different regional markets with just one car model is not an easy, but time consuming and therewith costly task for OEM's today. Each car model has to pass many crash tests, load cases and simulation runs have to fulfill the different regional safety requirements and regulations.
Simulation of crash tests as explained by the regulatory boards also require positioning of various barriers in numerous positions. This is a very humongous task if done manually.

2 Capturing Best Practice: Barrier Positioning for Various Impact Regulations

The "Barrier positioning tool" of Visual-Crash DYNA aims at supporting the CAE engineer to position the barrier quickly and efficiently as per standard regulatory norms, viz., FMVSS, IIHS and EURO-NCAP.
As per the various regulatory parameters the tool positions the barrier automatically. Once the barrier is well positioned, the tool also guides user through the subsequent process easily. The guided workflow begins with entering required data set-up such as applying barrier constraint (for ODB),

defining contacts between barrier and vehicle, defining initial velocity based on model unit and rigid wall modifications if any.

A user friendly and wizard guided graphical interface is used to position the barriers.

2.1 Barrier Positioning with Visual-Crash DYNA

2.1.1 Panel Description

The Barrier Positioning tool provides a vehicle safety engineer with a collection of load cases, tools and operations to follow the regulations easily with high efficiency. The toolkit contains many basic operations, algorithms, assessment mechanisms, and several additional data transformation features.

Fig. 1: Collection of available load cases”

2.1.2 Test Case

The GUI splits each modeling task in a separate tab, which helps user to concentrate on the next necessary steps.

The user selects from the library the applicable impact type for Front-, Side- or Rear-Impact regulations. Based on his decision the requested regulation (FMVSS, EURO, IIHS etc.) the barrier type will be updated in the dialogue. A small thumbnail shows the picture of the expectable test case.

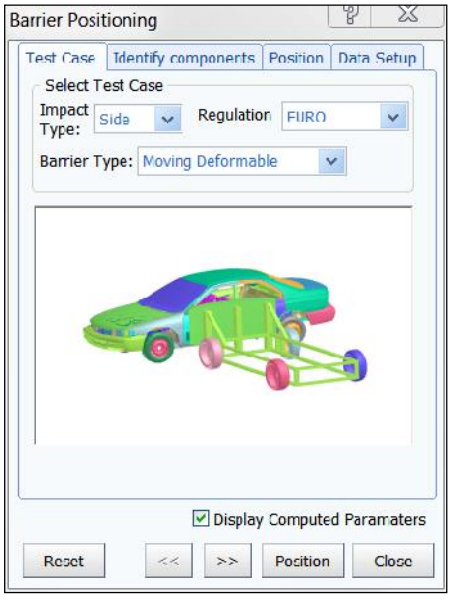

Fig. 2: Barrier Positioning Wizard in Visual-Crash DYNA

2.1.3 Identify components

Computing the barrier positioning requires a few necessary user interactions.

Vehicle and Barrier need to be identified as well as some common constraints like directions and units.
Various entity selection techniques, dialogues and the entity highlighting in the 3D model window support user to select the desired vehicle parts and/or include files. The barrier model can be imported with a File Browser or selected via entity selection. Rigid walls or static poles can be created on demand as service.

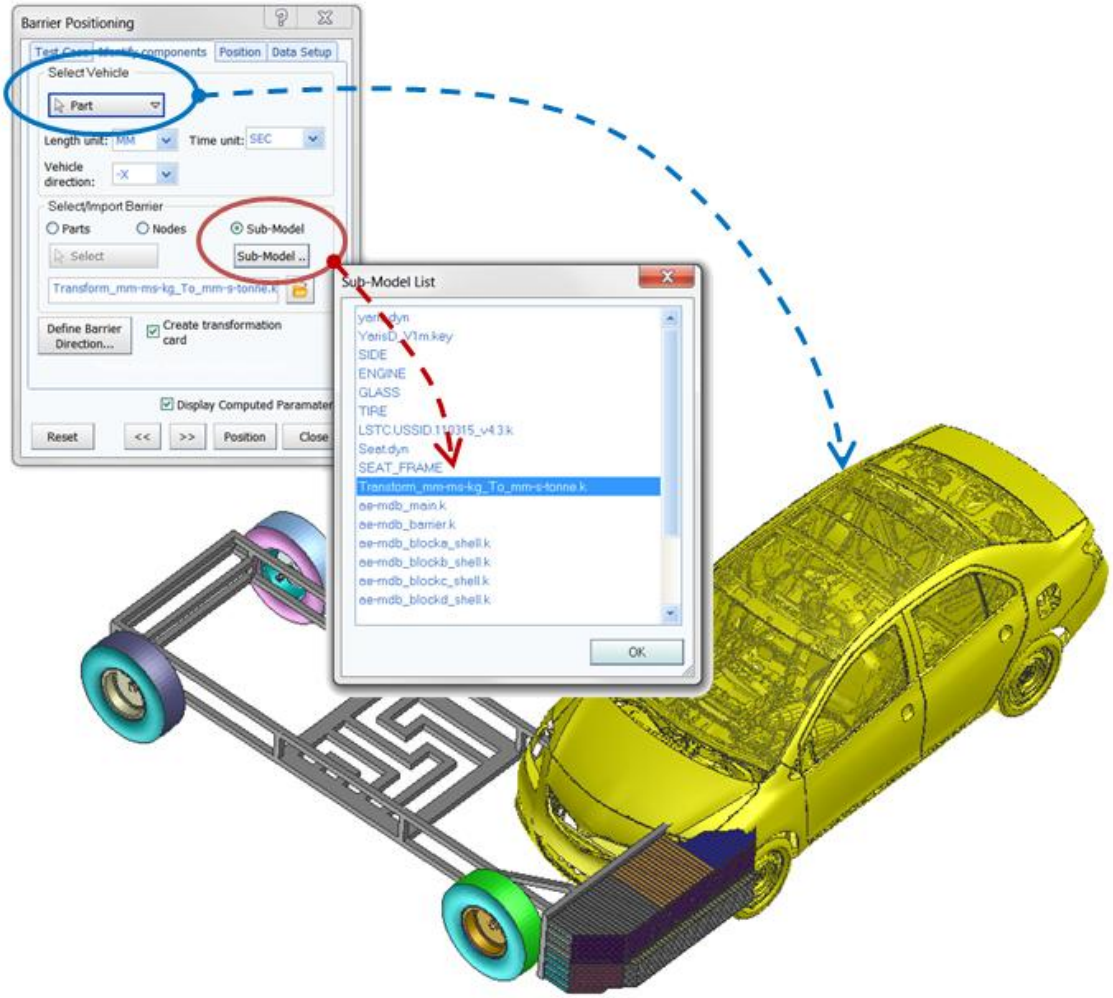

Fig. 3: Vehicle and Barrier selection

2.1.4 Barrier Positioning

The Positioning tab is case sensitive. Some regulations request to select model parameters like wheel centers and door points. To help users identifying dedicated points, reference lines or car dimensions Visual-Crash DYNA help appendix is updated with regulation information and meaningful pictures.

While identifying the components user can either create a *DEFINE_TRANSFORMATION card for the barrier include file or move node coordinates. To take advantage of Visual-Crash DYNA as comprehensive pre-pro cessor it provides full access to include structure and model editing. This allows users moving all new created LS-DYNA entities and solver cards in any include file.

The 3D model window is linked with all explorers and dialogues. Thus given, it allows dedicated entity highlighting. The most valuable advantage of this behavior is that any entity creation or selection will be shown as a graphical reaction in the model window. The risk for engineers inducing errors is therewith reduced to a minimum. Displaying the computed parameters for cross-checking purpose is a logical step.

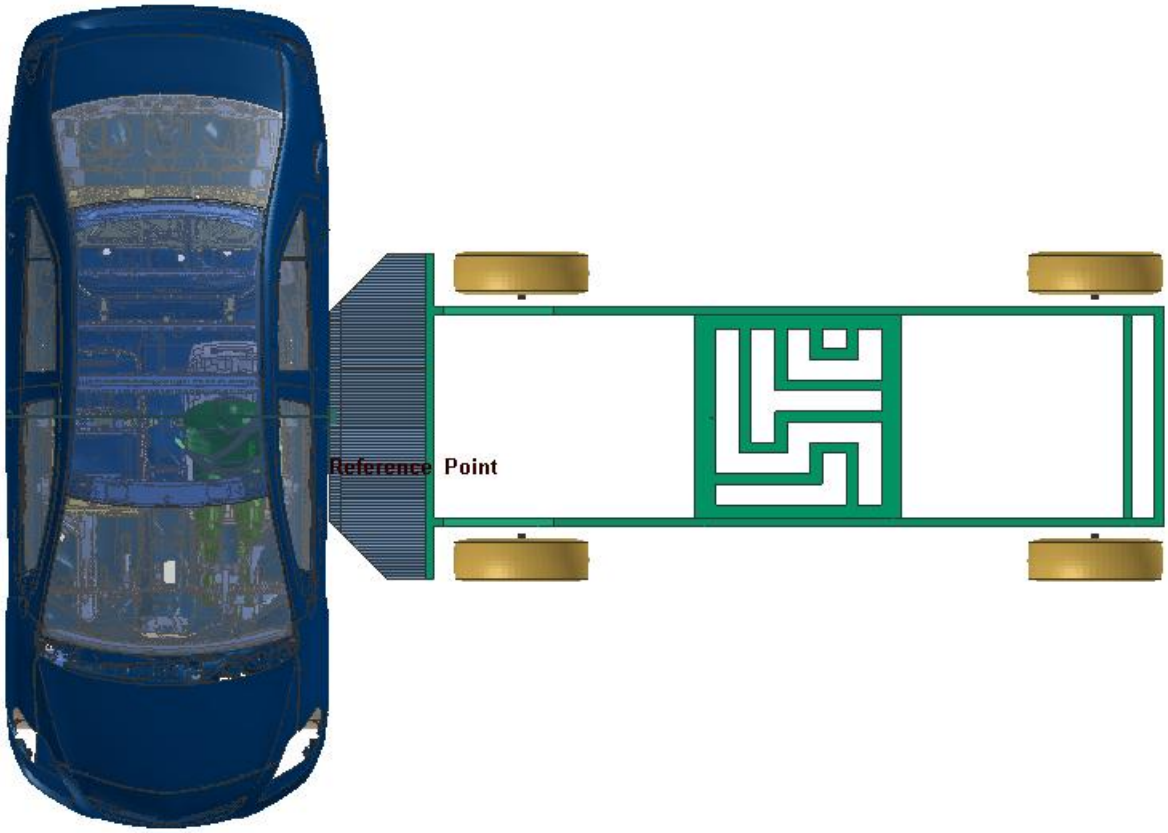

Fig. 4: Positioned Barrier selection with reference lines

2.1.5 Defining Data setup and Constraints

If necessary the tool provides possibilities to complete the data setup with creation of barrier constraints, vehicle barrier contacts and initial velocity. By toggling on this option, self-contact between barrier and vehicle will be created and initial velocity will be applied to all components depending upon case. All created entities can be easily edited with a solver related Card Image.

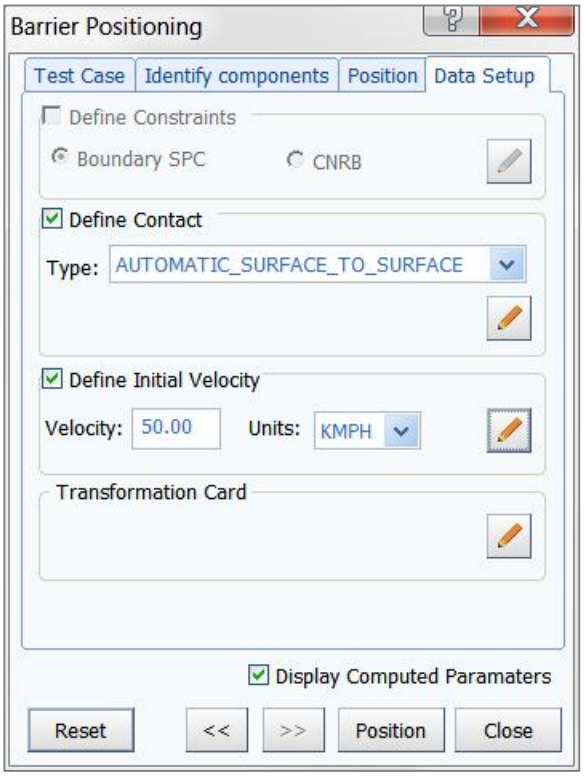

Fig. 5: Tab to define solver related entities

The GUI is designed that each step, selection or option can be changed at any time as long as the GUI isn't closed. This gives users the possibility to easily get familiar with all available options.

Finally the barrier will be positioned based on regulations and collected/selected input parameter.

2.2 Macro and Process Automation

2.2.1 Macro supports Barrier Positioning

Visual-Crash DYNA is designed to offer end-users many ways to create and customize their own configurations and tasks. The macro tool allows assembling a sequence of operations to generate repeatable tasks. While recording a macro, various steps can be triggered as a variable. After creation of a macro these variables enable users to create their own configuration without deep scripting knowledge.

When the macro is updated the process can be automatically rerun in order to reflect the design change.

2.2.2 Process Automation

The Process Application offers a tailored application in Visual-Environment that efficiently guides crash engineers in CAE model building. Starting from vehicle and barrier model and finishing with a runnable solver deck in LS-DYNA solver.

The process template is defined as a combination of specific tasks that are smoothly connected together in a workflow. The complex procedure is divided into sub-tasks such as sub-processes, and further into blocks.

The **Frontal, Side and Rear Impact Processes** guide users to setup an LS-DYNA analysis deck for various regulatory norms, viz., FMVSS, IIHS and Euro Regulations.

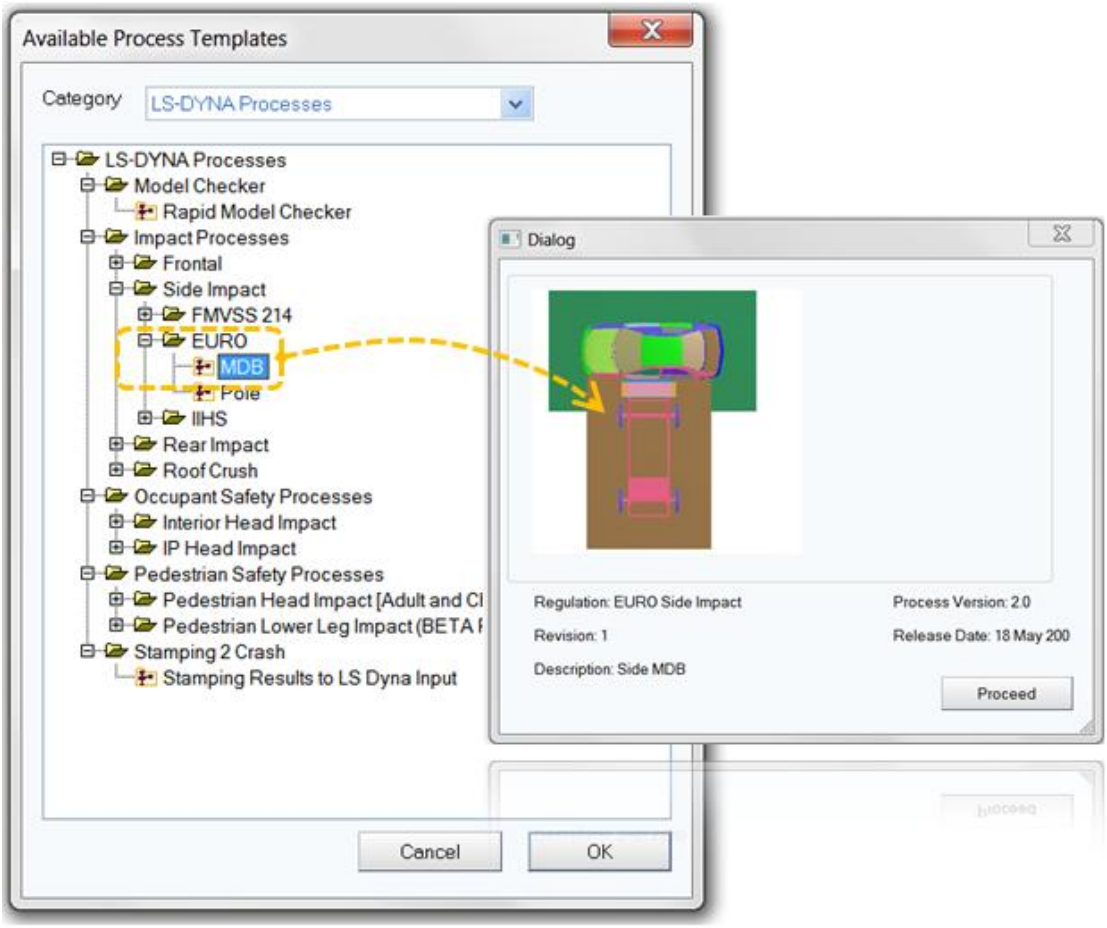

Fig. 6: Select the EuroNCAP Side impact process from the available processes

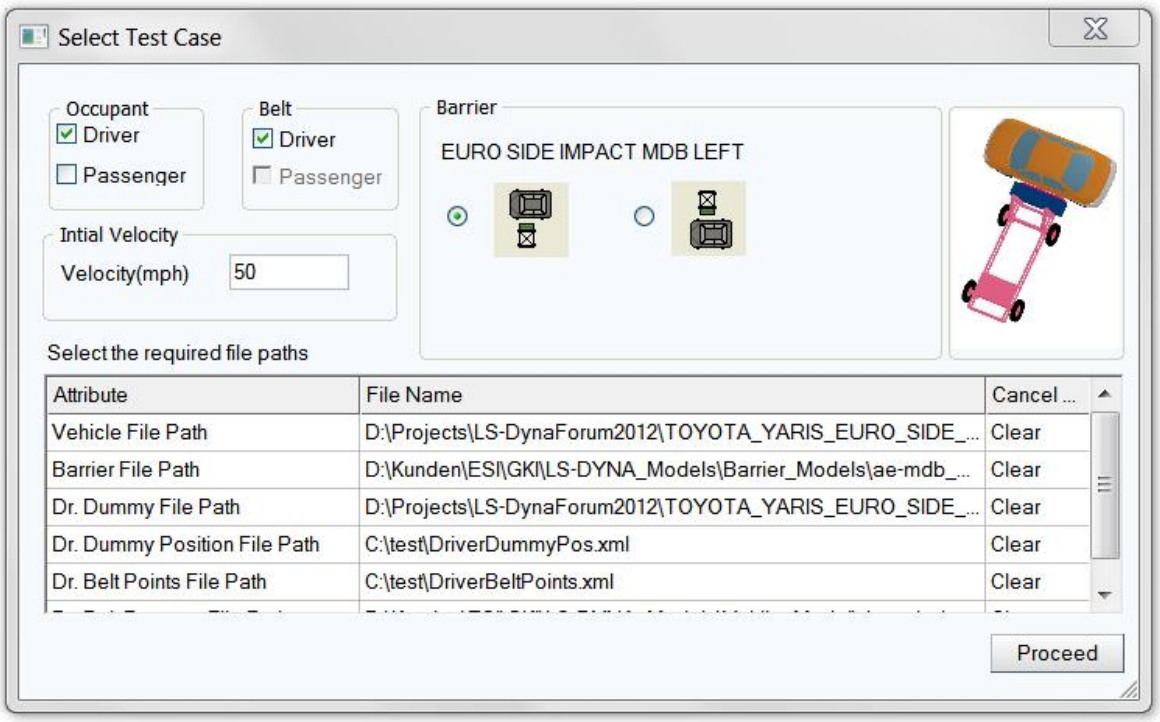

Fig. 7: Selection of the required entities will help automation process for further variants

Separate blocks help users to import and position barrier model, preparing dummy and creating seatbelts. Any entity or component which has to be created like Time History, Accelerometer and Section Force will be identified in the previous block.

Model Check block enables users to check the vehicle model for kinematics, element quality, mass and inertia, and penetration. It also has an additional feature, where users can undo or skip a particular block execution.

Ensuring engineers guidance but complete freedom while modeling with process technology, users can switch between Process Application and Pre-Processing capability in Visual-Crash DYNA at any step in the process flow. Therewith modification and creation of entities is possible at any time in the process. Furthermore finishing the once started process with the values of in between updated entities is guaranteed.

The final model will be exported to the project directory. Each model will be exported as an include file and saved in the project directory. This process can be executed in auto batch mode, where no user interaction is required or Interactive mode.

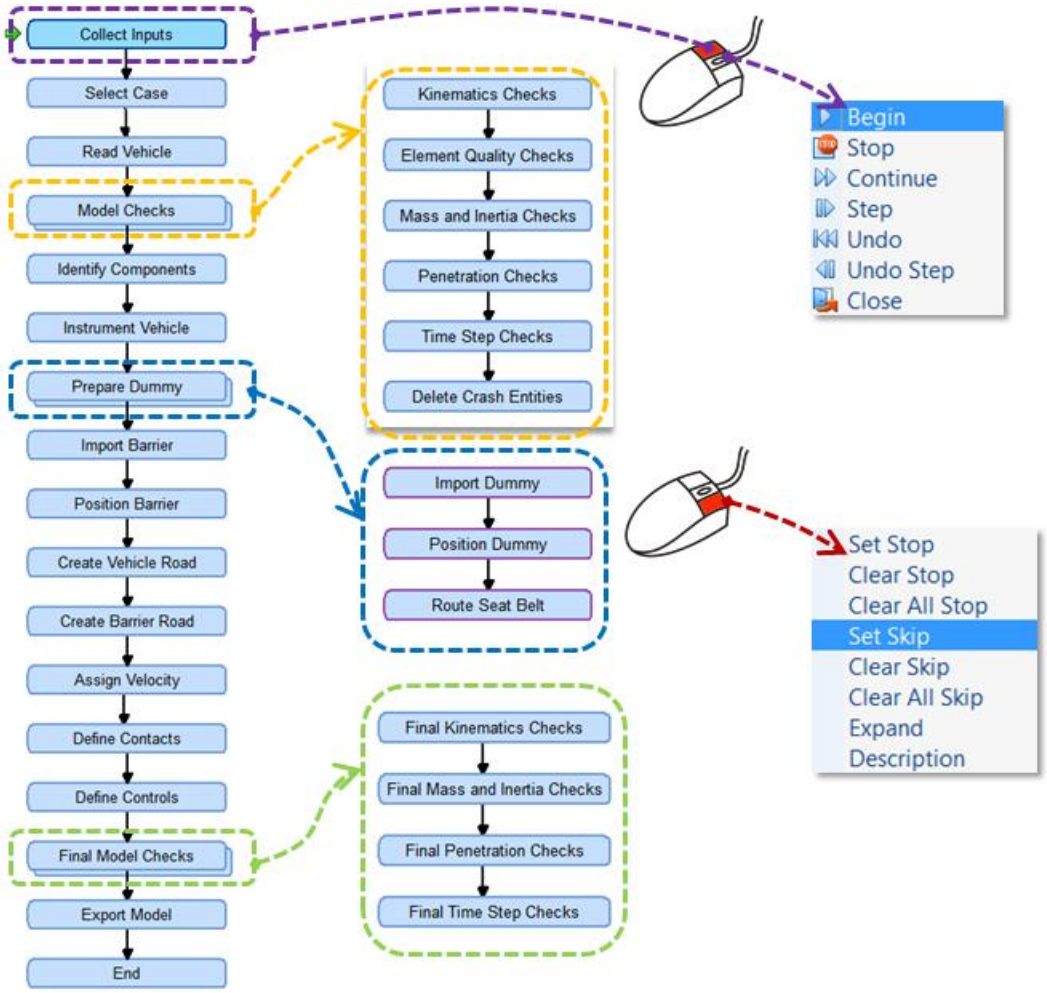

Fig. 8: Full Process Template with sub-processes

3 Benefits

Visual-Crash DYNA is a very easy-to-use, highly accurate pre-processor software that specializes in simulation of crash and safety processes for LS-DYNA. Barrier Positioning is part of Visual-Crash DYNA and guides the engineer through complex positioning processes. The tool includes all individual tasks during the development of positioning; built-up from CAE expert setting the boundaries between distinct modeling actions and predetermining all modeling parameters that must be respected, leaving to the inexperienced user a minimum degree of interference and limited or none decision making.

The Automatic Barrier Positioning tool combines with high ratio the ease of use with high quality simulation. Furthermore, coupling Barrier Positioning with a full process automation template, session files and macro support offers a complete positioning process solution and supports Visual-Crash DYNA as pre-processor for LS-DYNA solver. It shortens time per design iteration and captures best practices.

4 Literature

[1.] "Accelerating Regulatory Test Simulation with LS-DYNA through Process Guidance Technology" ,Petter Sahlin, "5th European LS-DYNA User Conference"

[2.] Visual-CRASH DYNA help manual, ESI Group, 2012

Pictures from TOYOTA Yaris model are kindly provided by LSTC