Fast New Methodology for Regulatory Test Simulation

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Abstract

Preparing a simulation model for a crashworthiness or occupant safety regulatory test is often a time consuming task. This paper describes a new methodology that significantly reduces this modeling time, down to minutes. Using predefined FMVSS standards, EASi-Process allows users to access ready made test templates for common runs (such as FMVSS 201, 208, 581...). With the integration of EASi-Process, EASi-CRASH DYNA, premier pre and post processor for multi-body and finite element occupant safety simulations using LS-DYNA, allows the user to select the type of test to perform and the structure to perform it on, and the technology takes care of the rest.
This technology, combined with EASi-CRASH DYNA, has proven to have dramatic benefits regarding cost and productivity for engineers and the enterprise.

Introduction

Today's vehicle systems and subsystems are engineered using established CAE processes to optimize their design for Stiffness and durability, Noise and vibration, Crash worthiness and Occupant safety, Sealing etc. Federal standards, such as FMVSS 201 (Head impact), 208 (Frontal Crash), 214 (Side Impact), 581 (Bumper Impact) are very frequently carried out in engineering simulations using various pre-processors and post-processors. These generally include creation of baseline CAD data, preparation of FE models, formulation of the analysis problem in the appropriate solver language (including determination and application of loads and boundary conditions), submission to solver program to obtain analysis solution, post-processing of the results and finally writing a report. Each of these processes itself could comprise of complex sub-processes and may even include exchanging data between different solvers. The time consuming tasks, from preparing the simulation model to report generation, can be carried out in an automated environment resulting in productivity and enterprise benefits. This paper describes the methodology that will significantly reduce the modeling time down to minutes.

Conventional Approach

CAE experts, as part of product engineering, execute the processes for several iterations of "what if" scenarios in order to optimize the design solutions and satisfy all requirements, and in the process make changes to geometry, load cases or boundary conditions. Sometimes the same analysis may have to be conducted on several competitor image vehicle systems/subsystems for comparison.

Conventionally, this process is conducted using general purpose pre and post-processors, which is labor intensive and requires from the engineers a high level of concentration during process execution to ensure that no error was made during model definition, analysis, post-processing and result interpretation. The engineers' attention and energy is spent more executing the processes than in engineering the product. CAE engineers have to not only manage all the data but also need to ensure that every aspect of the process is per current corporate practice. The burden of procedure consistency, repeatability and accuracy lies entirely on the CAE engineer. When a different person, a different group (even within the same company), or the same person at a different time performs the analysis, there is a real chance of obtaining different results. This is because conventional process execution does not lend itself well to standardization and repeatability.

One of the attempted solution to tackle this problem is to use scripts and session files. Although these do to a marked extent reduce drudgery and increase repeatability, they are unfriendly, unintuitive to learn, unforgiving (no undo), and often times neither graphical nor interactive. They require higher levels of user expertise, care and concentration. Also, it is not easy to pause, bypass or step through the process. For these reasons a particular script or session file does not find itself being used corporate wide.

CAE Automation

The methodology described in this paper solves this problem of carrying out analysis processes with ensuring every aspect of process as per corporate practice through CAE Automation. First, the best practice needs to be captured from CAE users, corporate and federal standards (such as FMVSS, IIHS, Euro, ACEA….). This captured practice is then implemented in a set of templates of process and sub process tasks with intuitive graphical interface. Unlike the conventional scripting and session file running, the process flow of the task sequence is provided to the CAE user with necessary execution flexibilities such as pause, bypass or step through the tasks including manual and automatic modes.

The data management difficulties are also addressed with improved data organization within the process execution by providing corporate defined or standardized data pool. The automation is allowed to pick the necessary data such as CAD/FE models of sub systems and systems, component properties, occupant position, seat belt configuration, variable load and boundary conditions, input/output controls.

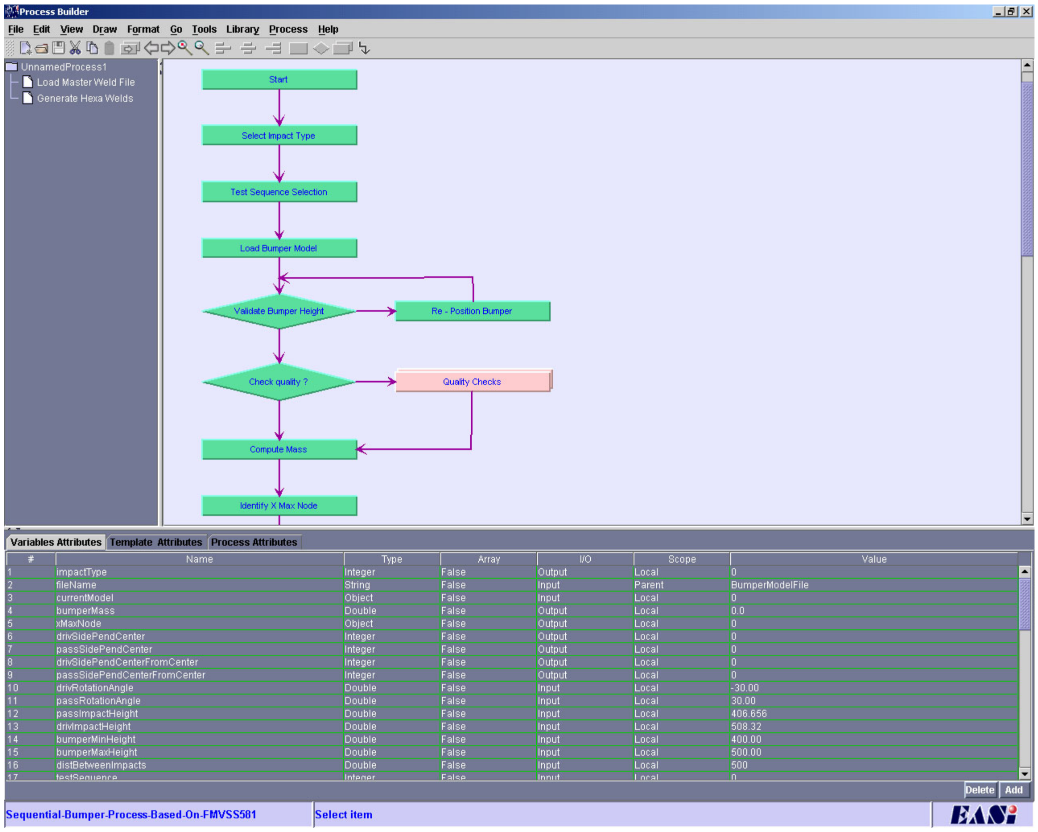
EASi-Process is a software environment that enables such automation of CAE process simulation. It is developed as a complete solution to this problem and is the first integrated environment for creating, automating and standardizing CAE processes. EASi-CRASH DYNA is a premier pre and post-processor for LS-DYNA within which the EASi-Process can be integrated to select and run the predefined templates of the CAE process.

Capturing the Best Practice

The key aspect of building an EASi-Process is to first understand the CAE process itself. The process flow template must be derived from the experienced user's best and standardized practice to distinguish all inputs and outputs and recognize the function of each task including breaking up complex process tasks into simpler sub-processes. User interactions in each task must be identified and the flow of control from task to task, including all loops, be understood. All necessary formulae required to calculate various parameters in the process must be clearly determined.

Building the Process

The process flow template is assembled within “Process Builder”. “Process Builder” is a graphical interface developed within the EASi-VISTA architecture and dedicated to building process flow templates. A typical “Process Builder” layout is shown below:



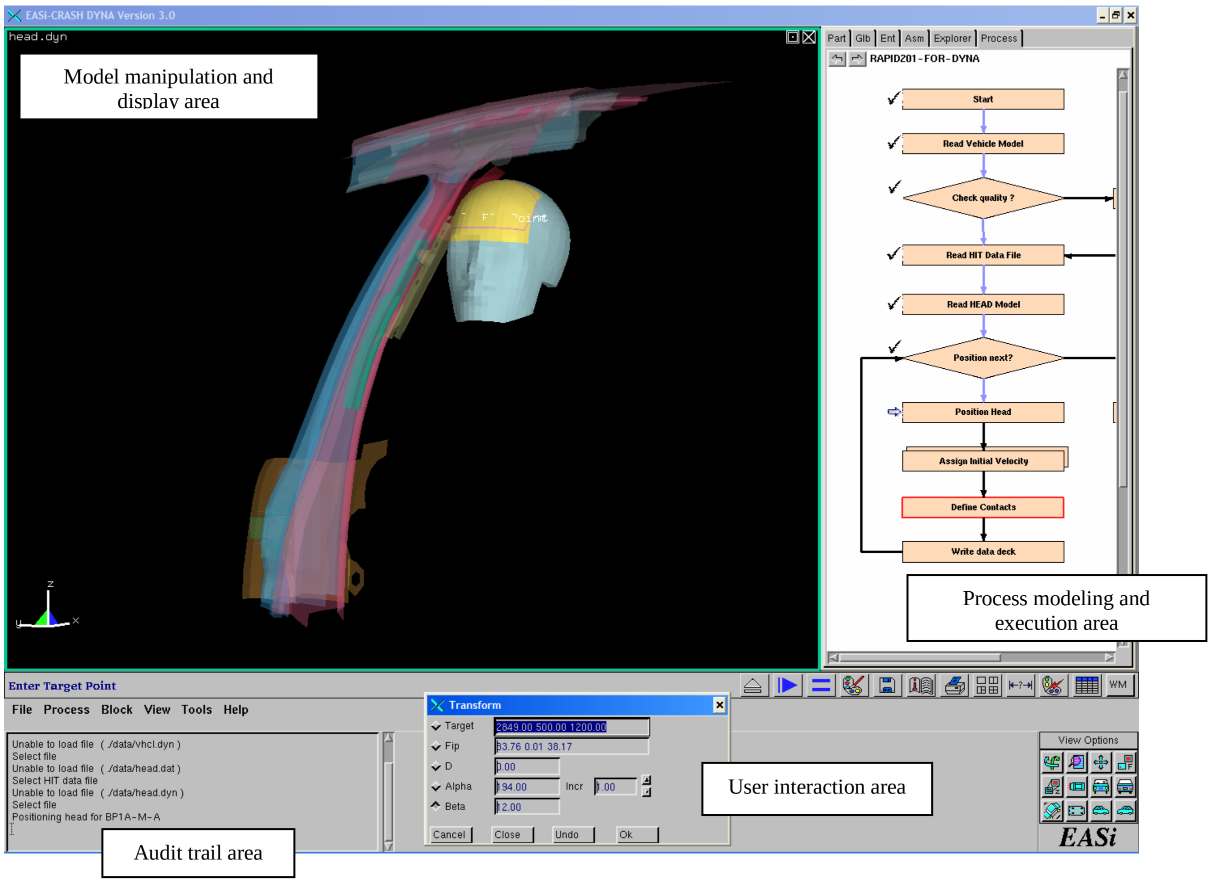
EASi-Process Builder

“Process Builder” contains a set of software modules and object libraries for various CAE tasks, which the user can add to. Each task is represented by a process block. Each block is provided with a knowledge advisory that captures the expertise of experienced users. The desired report layout format is envisaged and implemented in the “Generate Report” task block. This may include corporate standard cover pages, headers, etc.

For a number of standard tests (e.g. FMVSS 201, 208, 581, Euro pedestrian impact and head impact), ready made templates can be provided in EASi-Process and are already integrated within EASi-CRASH DYNA. Additional templates can be designed and implemented either by ESI Group or by the client.

Executing the process

A user friendly and intuitive graphical interface (mainly called as EASi-Process) is used to execute the process flow templates. The predefined, built process templates are provided in process executor list. The interface layout is shown below:



EASi-Process (Executor)

It is composed of a) Process modeling and execution area, b) Model manipulation and display area, c) Audit trail area and d) User interaction area.

When the user selects the desired template, the process flow template is imported in the "Process modeling and execution" area. The execution area has the capability to run the complete process or individual task block, and includes execution controls such as pause, bypass, step through and automatic mode.

The model is displayed in the "Model manipulation and display" area. This is the area where users can input FE entities, screen select FE components, nodes, and elements, and where animations will be displayed.

The audit information of each task block is given in the "Audit Trail" area as the process is executed task by task. This may be exported as an appendix in the report which will be useful to the supervising engineer to verify that the process was executed properly. This area also provides the key note, intermediate computed results to the users with necessary comments and feedback.

The "User interaction" area will be activated whenever the user interaction is needed (text input, query response or option selection).

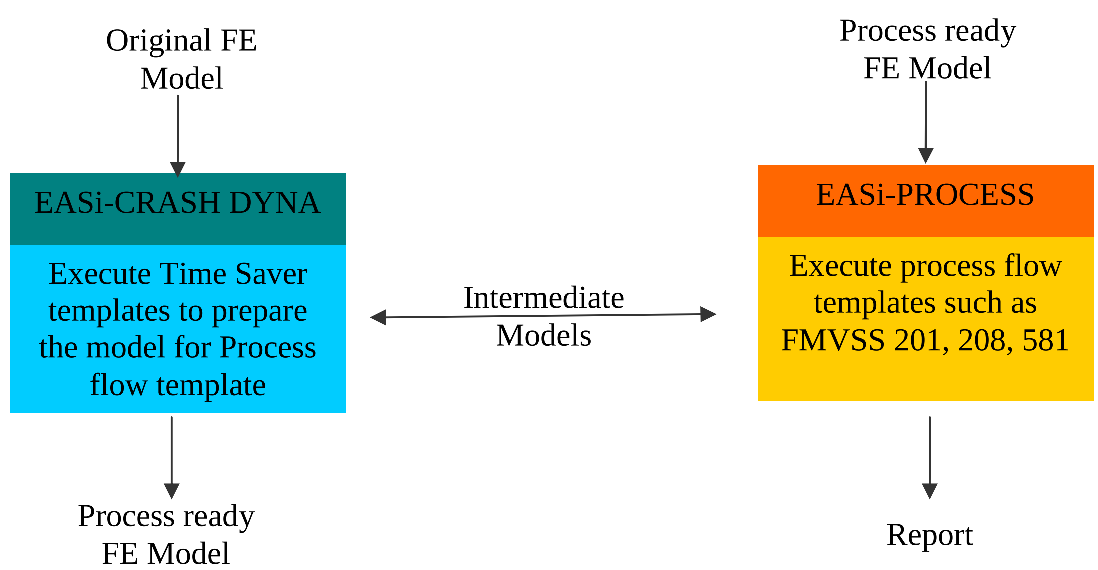
At any time during process execution, the user can request more information or guidance by picking the appropriate task block. A knowledge advisory capturing the corporate best practice with hints and suggestions is provided for each task block.

Process and Setup Interaction

The process executor can be integrated within the EASi-CRASH DYNA environment for quick interaction and model setup. During the process execution itself, a particular task can be performed in the EASi-CRASH DYNA graphical interface before the process execution continues.

Scenario

The predefined templates for regulatory tests such as FMVSS201, 208, 581 and Euro pedestrian impact are provided in the EASi-CRASH DYNA environment, including the necessary model setup templates. To use one of these templates, the user only needs to import a fresh geometry to carry out the test on (e.g. FMVSS 201), and execute the model setup template (for EASi-Process). The output from EASi-CRASH DYNA will be a complete ready to run LS-DYNA model, which can be used for a single run or several iterations of different regulation parameters in automatic execution. If any intermediate task, which is not readily available in the process flow template, needs ot be performed, the user can switch back to EASi-CRASH DYNA completes the task and returns to EASi-Process to continue the execution. A schematic diagram of this scenario is given below:



Benefits

This process automation, based on EASi-Process, allows the following benefits to be realized.
Productivity:

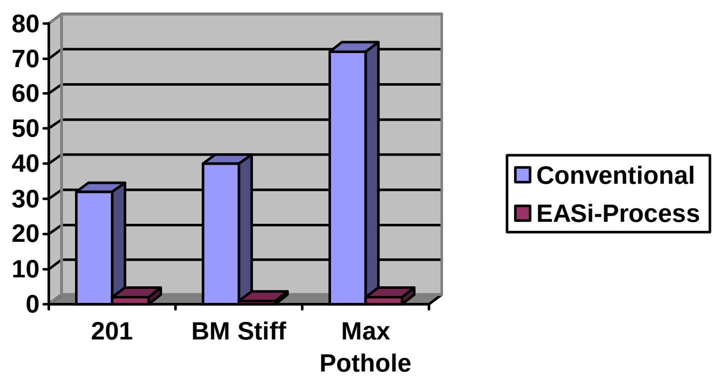
- Shortens time per design iteration,
- Reduces drudgery, inconsistence and errors,
- Streamlines book keeping,
- Decreases expertise requirement to prepare models and process results,
- Frees CAE expert to focus on value-adding engineering for product development,
- Provides intuitive environment, ideal for new users and non-specialists.

Enterprise Benefits:

- Captures the best practices and enables enterprise-wide standardization,
- Institutionalizes processes, reduces training time,
- Enhances resource mobility.

Benchmarks

Benchmark studies with major auto manufacturers and suppliers for selected EASi-Processes such as body mount stiffness computation, head impact analysis and max pothole durability analysis revealed overall time saving of 30:1 to 48:1. The bar charts given below show the man hours time savings for the respective processes:



Summary

The landmark technology of EASi-Process integrated with EASi-CRASH DYNA allows analysis processes to be implemented with automation techniques in a company towards enterprise wide standardization. It alleviates CAE engineers from drudgery involved in conducting repetitive processes and frees them to truly spend their time in value added engineering for product development. Accuracy and consistency of reports are assured and the immediate benefit realized is extreme productivity.

References

1. EASi-Process: Technical Whitepaper, Thirumurthy Nallasamy, Prakash Krishnaswamy, Sural V, EASi Inc. (2001)
2. EASi-CRASH DYNA Users Manual, ESI US R&D (2003).
3. EASi-VISTA Reference Manual, ESI US R&D (2003).
4. FMVSS Documentation, NHTSA.