Productive Environment for Quick CAE Modeling and Simulation – Visual Environment

Shivakumara H Shetty, Velayudham Ganesan, Nagesh B L, Jean Louis Duval
ESI Group
36800 Woodward Avenue, Suite 200
Bloomfield Hills, MI 48304
USA
Ph: (248) 203-0642
Email: info@esi-group-na.com
URL: www.esi-group.com

Abstract

The current trend of Product Development Cycle needs to be optimized to meet the growing demand for robustness, quality and fast to market. High competition, mandatory regulations and global norms are forcing the engineers and researchers to evolve with innovative ideas and solutions to meet demands. CAE plays a crucial role in the product development cycle where the FE modelling and simulations are preformed for virtual evaluation of the products. Commercially available CAE tools and software are used for such problems. ESI's EASi-CRASH application is one of the tools widely used in CAE world mainly by automotive industries. In order to meet such CAE users expectation of fast paced product development, ESI's Open VTOS (Virtual Try-Out Space) solution provides a platform for achieving the desired productivity and results in the virtual prototyping environment.
Visual-Environment (VE) is the major enhancement of EASi-CRASH application. Virtual Prototyping methodology has made significant contribution in enhancing the productivity, reliability, usability and robustness. VE is an integrated suite of solutions, which has different contexts seamlessly linked for Crash and Safety simulation. Visual-Crash DYNA (VCD)-a pre processor for LS-DYNA, Visual-SAFE-an advanced pre-processor for safety features, Visual-Mesh a general purpose mesher, Visual-Viewer (VVI)-a general purpose plotting and simulation application, Visua-Life Nastran (VLN)-a general purpose pre processor for NASTRAN, Visual-Process Executive-an application for process customization and repetitive tasks automation are the contexts to name a few.
This paper describes the key modelling features and usefulness of Visual-Environment in Crash and Safety simulation with productivity examples and process automation.

Key words: Product Development Cycle, CAE, FE, Virtual evaluation, EASi-CRASH, Open VTOS, Enhancement, Visual-Environment, Virtual Prototyping, Crash, Safety, Process, Productivity.

Introduction

Visual-Environment (VE) is the first brick of the new environment for ESI Group's leading crash simulation software. Visual-Environment has been built by merging ESI Group's Open VTOS solution into EASi's VISTA[1] technology. The embedded VISTA data model offers a very versatile environment where new applications and interfaces can easily be implemented. VE is advanced pre-post application supported in all OS platforms including native windows and 64-bit version. VE provides session execution and command driven environment. It is a context based environment based on different FE modeling needs such as Visual-Crash Dyna (VCD) for LS-DYNA, Visual-Life Nastran (VLN) for NASTRAN, Visual-Mesh (VME) for meshing and model assembling, Visual-Viewer (VVI) for post processing, Visual-Safe (VSA) for advanced safety applications, Visual-Process (VPR) for CAE process automation and so on. All the contexts are integrated seamlessly; facilitate the user to navigate within one environment with multiple solver accessibility.

Visual-Environment Contexts

As mentioned above, VE has several contexts out of which a few are explained below from the LS-DYNA users point of view. All the dialogs are easily scriptable through Python language for quick customization.

Visual-Mesh

Visual-Mesh is a complete meshing tool, which supports CAD Import, 2D and 3D Meshing and editing features. It also provides batch-meshing utility based on topology meshing with user guidance as well as automatic approach.

Visual-Crash Dyna

Visual-Crash Dyna (VCD) is the enhanced version of EASi-CRASH DYNA inheriting all other standard features of VE that makes VCD to be highly productive tool. It provides users with fast iteration and rapid model revision process, from data input to visualization for crashworthiness simulation and design. This environment provides quick model browsing, advanced mesh editing capabilities and rapid graphical assembly of system models. VCD allows graphical creation, modification and deletion of contacts, materials, constraints, control cards and all crash entities. In VCD, model validation tools helps in correcting errors and improve the model before submitting it to a solver, thus saving time and resources.

Visual-Viewer

Visual-Viewer is the advanced Post-Processing tool with state-of-the-art Plotting/Viewing utility. This caters to the requirements of the CAE community. Viewer is built on the multi page/multi plot environment, which enables the user to group data into pages and plots. Viewer is designed with intuitive and sleek user interface as windows-look-and-feel. Complete plotting session is captured and it can be re-executed without losing any data. It is also fully command-driven that enables the user to execute at command-line.

Visual-Process

Visual-Process is an advanced CAE environment for process customization and automation. The process templates establish high productivity and standardization by customizing any regulatory CAE procedure such as FMVSS, ECE etc and corporate best practices. The environment's state

of the art process execution methodology allows carrying out the model building automatically and semi automatically for consistent results. The process templates for FMVSS201, Pedestrian head impact target identification are to name a few which are available in Visual-Process Executive context.

Productivity Improvements through Visual-Environment

In Visual-Environment productivity improvements are achieved by quick CAE modelling and simulation at two different levels, through:

- Productivity Features
- Process Automation

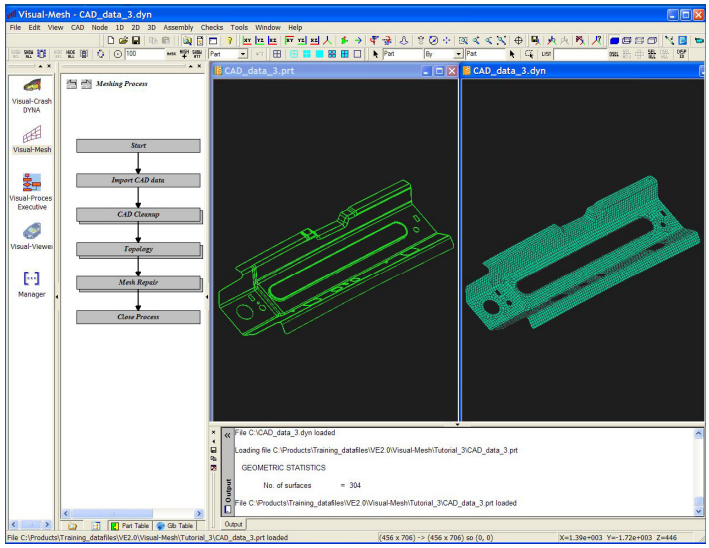
Productivity Features ease the modelling of a specific task in the model build-up or post-processing. A few frequently used features are discussed below.

1. Topology and Batch Meshing
2. Model Assembler
3. Weld Tools
4. Intersection and Penetration removal
5. Advanced Part Replace
6. Coupling LS-DYNA FE with MADYMO rigid body models
7. Automatic Seatbelt routing and Dummy positioning
8. Seat Morphing
9. Advanced Post processing options

Productivity Features

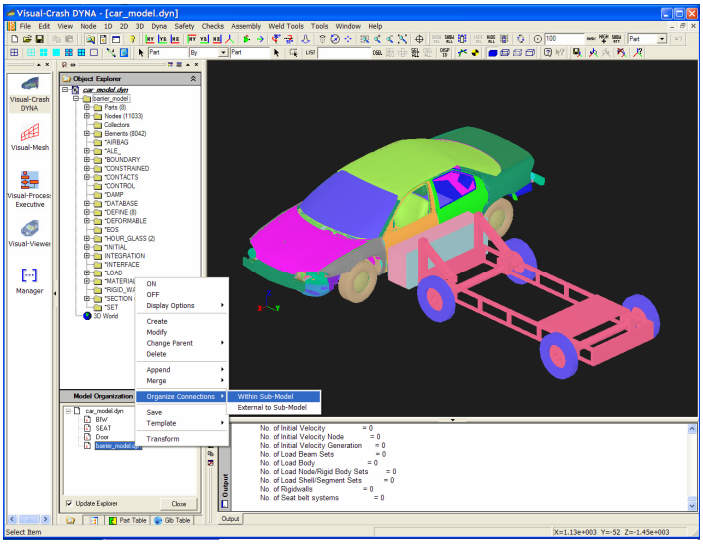
1. Topology and Batch Meshing:

The Meshing Process feature guides the user to mesh the given CAD component automatically. This process uses the concept of Topology. Meshing components manually consumes lot of time and also lacks consistency. This makes the process guidance approach more reliable and consistent. A process template is setup in such a way that it minimizes the manual interaction in the meshing process.



It automatically cleans up the CAD data to get a good topology from CAD and in turn a good quality mesh. The template can be executed either in **Auto mode** or **Interactive mode.** In **Auto mode** it will be executed with default values and no user interaction is needed.

2. Model Assembler:



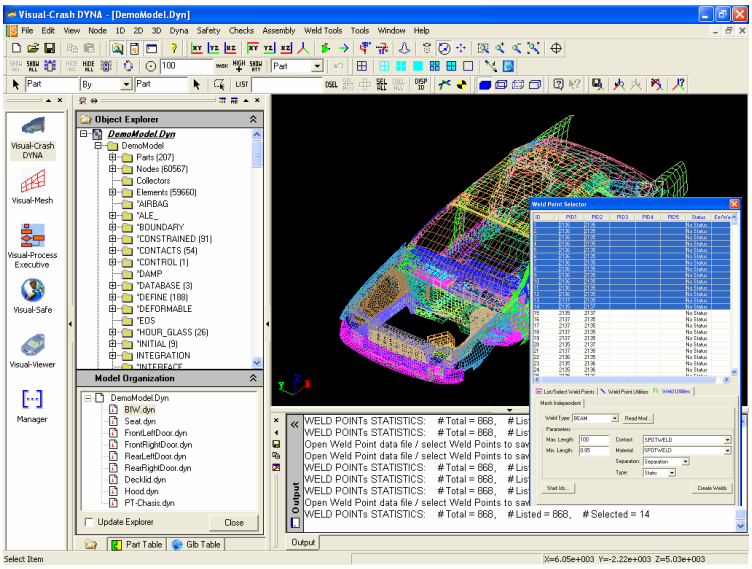
Organizing the data easily, quickly and efficiently:

- A very difficult and time consuming task of retaining include files without merging all data into one single model has become simple task in VCD.
- Creating, modifying, deleting and viewing of include files as sub-models and main model is available in the interface.
- Identification and automatic grouping of connections – both within and between sub-models (include files)
- Ability to locate any entity and identify the appropriate sub-model
- Ability to work with and export only selected sub-models as include files.

3. Weld Tools:

Advanced options for weld creation and modification:

There are several weld utilities available for LS-DYNA mesh independent and node-node weld elements creation and modification. An intuitive interface is also available which can be invoked instantly for viewing, validating the weld points and weld elements associated with the FE model.



One of the most valuable features is the weld comparison tool to compare master weld file and/or mesh independent welds between two different models. The feature identifies and displays the difference between two different models. The user can view the matching and/or un-matching welds, delete or copy the welds from one model to another.

4. Intersection and Penetration removal:

Through this feature the user detects intersections and penetrations in the model. Intersections are defined based on part–part, penetrations are defined based on part–part or contact thickness. Through semi-automatic or automatic corrections features, the productivity is dramatically increased. In semi-automatic mode nodes/elements are moved, along a node normal, a vector, through node alignment, or dropping on a plane to eliminate the initial penetration.

5. Advanced Part Replace:

VCD's multipart replace feature enhances the productivity of model assembling during iterative analysis when the user has to incorporate the design changes in the simulation model. The changes may be geometry and/or attributes. Users can achieve the following part replacing tasks with minimum effort.

- replace single part by multiple parts
- multiple parts by single part
- multiple parts by multiple parts.

The environment tracks the part connectivity and associated crash entities automatically.

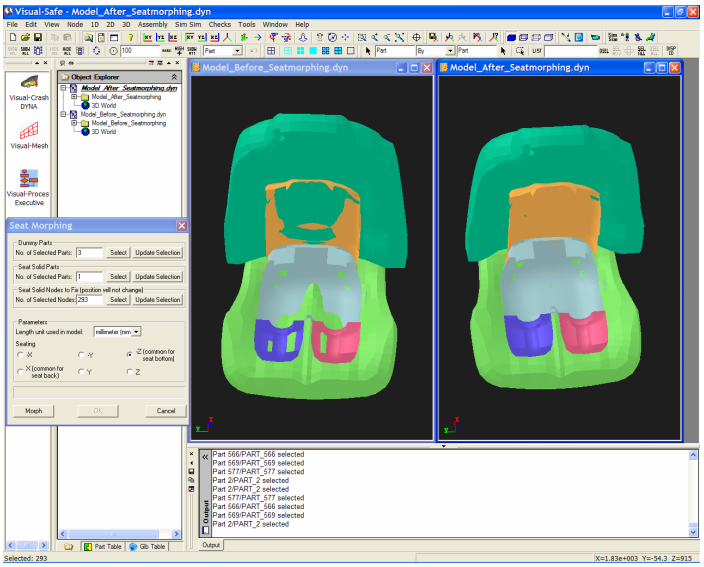
6. LS-DYNA/ Madymo Coupling

A unique feature of coupling Madymo rigid body models with LS-DYNA FE models is available with ease-of-use interface. VCD automatically takes care of creating the necessary coupling cards in LS-DYNA and Madymo models accordingly. ESI's VISTA data model enables both the LS-DYNA and Madymo data in single environment (only software for coupling interface available in industry now is EASi-CRASH DYNA[2]) to import and export without loosing associated coupling cards[3,4]. Coupling for latest version of LSDYNA 971-Madymo 6.3 is available.

7. Seat Morphing:

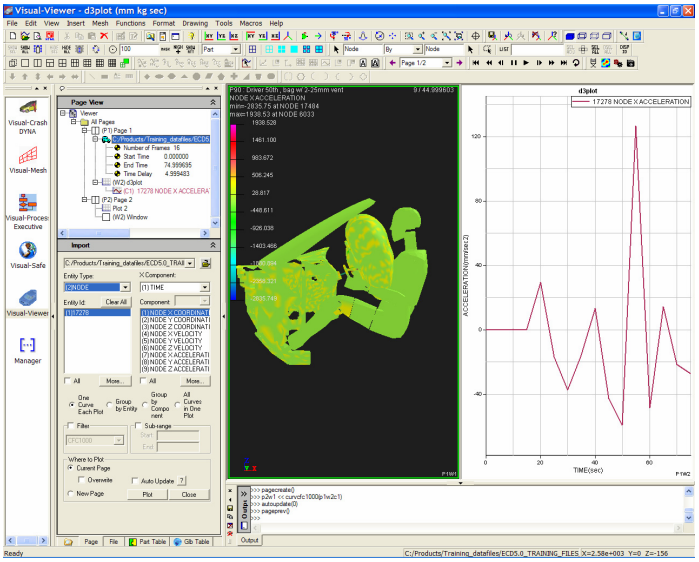
Automatic, pre-simulation based FE Morphing:

One another advanced safety modeling feature to improve the accuracy of dummy to seat interaction is provided in VE. The seat cushion can be morphed to suit the dummy profile based on physics. A pre simulation is done internally to arrive at the morphed configuration. Combined with the power of coupling this will enable rigid body dummies to have better seat interaction which improves the model quality in addition to the fast modeling.



8. Advanced Post processing:

- Integrated post processing environment for animation, visualization, contour plots, XY plots, and reports.
- Overlay and Synchronize AVI, Simulation results and Plot.
- Viewer supports complete session and command Driven Environment.
- Instant plotting of iterations using “CHASE IT”erations. Works for both test and CAE data.
- Intelligent sorting and Global control on data as well as template support are available in Viewer.
- Post processing templates can be quickly generated and deployed.
- Intuitive object oriented Python scripting interface is made available to manipulate the post processing data.



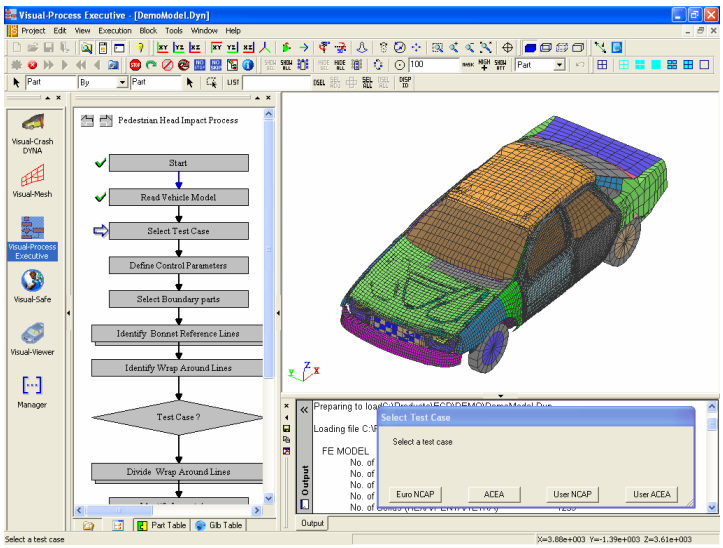
Process Automation

Visual-Process:

Visual-Process context in the VE environment enables the users seamlessly switch to Process Automation interface. In this interface, customized process templates are available to execute for particular modeling task automatically or semi-automatically. Visual-Process is an enhanced version of EASi-PROCESS[1]

Any regulatory test simulations such as FMVSS (201, 208, 214, 207, 210, …), IIHS, etc can be captured and automated in this environment. The best practice of model building and simulation can be captured and customized for any repetitive and time consuming tasks. This paves a way for time saving and more focus on engineering.

The Visual-Process interface provides run time flexibility to stop the execution and switch to different context and work with the selected context, and then switch back to Visual-Process to continue the process tasks. The model modifications performed in the pre processor are updated accordingly for the subsequent process tasks.



Productivity

A few proven productivity marks given below for the above features in EASi-CRASH DYNA are further improved in VCD taking the advantage of ESI's Open VTOS solution.

Feature	Conventional	VE, VCD
Part Replace (Assembly of 10 parts)	8-10 Hrs	< 45 min
Intersection/Penetration Corrections (#parts:100-150, #penetrating nodes:20,000)	20-24 Hrs	< 4 Hrs
Model Assembler (1-3 Mln Nodes, #submodels: more than 50)	10-20 Hrs	< 4 Hrs
LS-DYNA-Madymo Coupling (coupling about 65 madymo bodies)	8-10 Hrs	< 20 min
Plotting: Chase Iteration (6 iterations, each of 300 curves, includes filtering, function application on the curves)	6-8 Hrs	< 30 min
Process template (Frontal NCAP, Generic Coupling, IP-Knee Impact, Sled Test Modelling, FMVSS203, Report Generation)	Avg. 40 Hrs	Avg. < 10min

Summary and Conclusions

Most automotive OEMs and safety suppliers have substantial potential for improving the productivity of their pre and post-processing for LS-DYNA. This paper has presented what this potential is, highlighted how the productivity improvements can be achieved in ESI's VCD, and mentioned the CAE automation capabilities within VE for potential time saving.

Even though the presented solutions have proven significant improvements with respect to the conventional approach, there is still additional potential for time saving, especially through the combination of process automation technology and optimisation, robust system design techniques

References

1. Velayudham Ganesan, David Piesko, Jean-Louis Duval, "Fast NEW METHODOLOGY FOR Regulatory test simulation" Proceedings from The 8th International LS-DYNA Users Conference, 2004.
2. Shivakumara Shetty, Petter Sahlin, "Productivity Gain in Crashworthiness Simulation EASi-CRASH for Complete Safety and Crash Modeling for LS-DYNA", Proceedings from the 5th Euoprean LS-DYNA users Conference, 2005.
3. LS-DYNA 971 User Manual, LSTC, USA.
4. MADYMO 6.3 User Manual, TNO, Netherlands.