Visual*DSS*
CAE Data Management and Decision Support System for Simulation Life Cycle Management

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Abstract

Simulation industry has matured enough to carry out the design iterations using just the simulation results without relying on expensive prototype testing. Such simulation approaches have drastically reduced the product development lead time, cost and product failures. Engineers and managers spend most of their time on non engineering activities searching for information, learning simulation tools and workflows, hackneyed repetitive simulations, manual communication and manual simulation data management. The integrated simulation management system such as VisualDSS® (Visual Decision Support System) helps to outwit the current performances of simulation by addressing such non engineering areas of simulation.

VisualDSS is a simulation lifecycle management system from ESI's Visual-Environment suite which aims at providing end-to-end decision support for the simulations such as LS-DYNA® by providing integrated multi disciplinary simulation management features such as simulation data management, compute model management, simulation automation and workflow management, knowledge capture and reuse, simulation project management, results and audit trails processing, smart search and queries, inter enterprises simulation collaboration management and much more. This enables the enterprises to make better decisions, increase the simulation productivity, reduce the project lead time and cost, eliminate the simulation assets loss and improve the simulation reliability.

This paper describes the application of VisualDSS in the CAE industry catering multi domain simulation and data management with the objective of supporting decision making process.

Key words: Visual-Environment, VisualDSS, Decision support system, Simulation life cycle, Multi disciplinary, Simulation project management, Workflow management, Simulation collaboration management.

Introduction

CAE (Computer Aided Engineering) industry is developing rapidly to achieve the faster vehicle development. The cost of doing simulation is much cheaper than doing physical tests. Hence the simulation can help to do more iteration to study the product performance and to improve the product design. Most of the product validations are carried out in the early design phase[1] of the product development. In real world, it has been a challenge since many years in OEMs (Original

Equipment Manufacturer) and suppliers (of components and sub products) to have CAD-CAE communication as it has very significant business impact in the design phase in order to get the product fast-to-market. As illustrated in the Fig.1 the number of simulations is realized to be very high in the early design phase and reduces as the development continues. Also, in the early design phase the product validation is started by using lot of legacy data even before the actual product data. Therefore the simulations itself undergo a life cycle along with the product development.

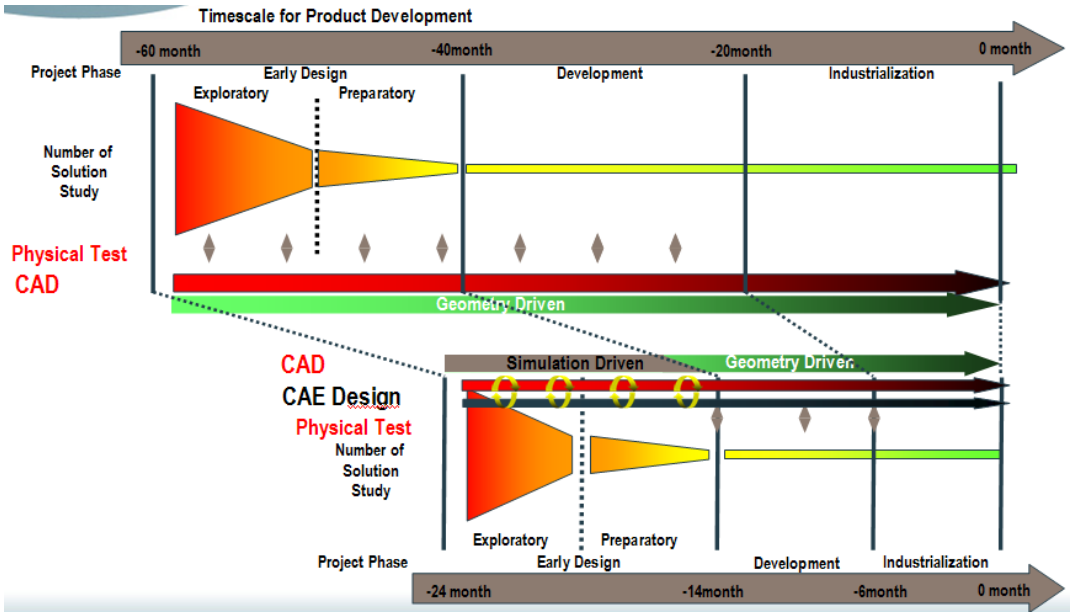

Fig 1: Product Development Phases[1]

A general overview of the CAD-CAE bidirectional communication, simulation life cycle management and simulation data management approaches are discussed using ESI's Visual*DSS* with respect to LS-DYNA simulations.

CAD-CAE Communication

CAE engineers while carrying out the simulations, spend lot of time searching for design information and exchanging of data between engineering and design. Whenever there is a design change, it takes its own time and effort to reach engineer depending on corporate workflow. Some times, the engineer is misled by the inappropriate version of the design updates. Unless there is well defined workflow or best practice to bring the design change timely to the engineer, there are chances that the engineer can make mistakes in the simulation by taking inappropriate designs. This involves many non engineering countermeasures and corrective actions that potentially add up product development time for each engineer. Even the engineers are given some level of access to the PDM system, due to vast information contained in the PDM data, the errors due to inappropriate design update is inevitable.

At the same time, when the CAE engineer proposes an engineering change to be adapted in the component, the current conventional notification mechanisms lack efficiency and productivity.

The interpretation of design engineer can mislead the entire design itself. Therefore a better and efficient communication between CAD and CAE still is mandatory.

Simulation Lifecycle and Data Management

The simulation industry has matured enough to carry out the design iterations based on the simulation results itself without relying much on expensive prototype testing. Simulation could reduce the product development lead time, development cost and product failures. Starting with legacy design data in the early design phase followed by actual design data, building FE (Finite Element) models, setting up solver decks such as LS-DYNA, running solver, interpreting solver results there are several iterations that CAE engineer executes on a particular simulation until a conclusion on the component/system performance is achieved. During the iterations, the simulation can take into account several design change until an optimized design solution is achieved, thus every simulation undergoes a cycle of activities along with the product development. There is large number of simulation data involved during the iterations of various simulations of different load cases. Without a well defined system, tracking all those simulations, managing simulation data to be able to refer in future simulations and design, taking a better decision, etc. is very difficult. Therefore a CAD-CAE communication alone is not sufficient but also an efficient simulation data management system is necessary.

Visual*DSS*

Engineers and managers spend most of their time on non engineering activities such as searching for information, learning simulation tools and workflows, hackneyed repetitive simulations, manual communication and simulation data management. The integrated simulation management system such as Visual*DSS* helps to outwit the current performances of simulation by addressing such non engineering areas of simulation. Fig.2 illustrates an approximate proportion of the CAE engineer time spending on real engineering and non-engineering activities in a simulation cycle.

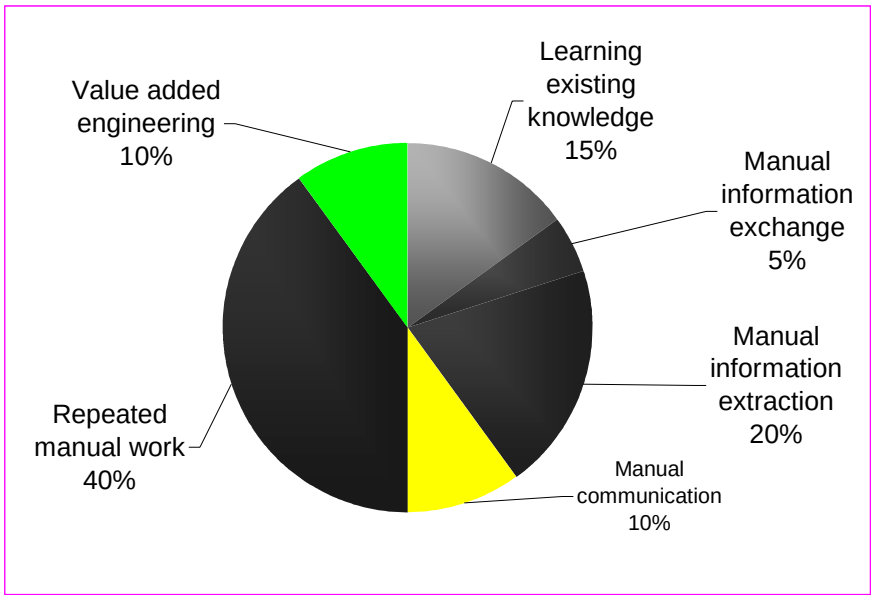

Fig 2: Engineers spend 90% of their time on non-value added activities

Visual*DSS* is a simulation lifecycle management system which aims at providing end-to-end decision support for the simulation based design[1]. It provides a bridge between CAD and CAE, integrates simulation management features such as simulation data management, multi domain model management, simulation automation and workflow management, knowledge capture and re-use management, simulation project management, results and audit trails management, smart search and queries management, inter enterprises simulation collaboration management and much more (some of the above are not described as they are beyond the scope of this paper). Having built on Visual-Environment's single data model[2], it provides a common environment for multiple simulation disciplines such as Crash, Safety, NVH, Structure, Aerodynamic, Electromagnetic, Electronics, Thermal and Manufacturing for any product development. This enables the enterprises to make better decisions, increase the simulation productivity, reduce the project lead time and cost, eliminate the loss and improve the simulation reliability.

Visual*DSS* is a client-server based simulation management environment. Rich-clients (desktop applications) and Thin-clients (web browsers) connect to the server and work on the solution modules that reside on the server. The rich clients are used for large data files viewing and editing (e.g. Visual-Environment, Visual-Crash Dyna, etc) whereas the thin clients are used for the light weight operations such as workflow, requirements or simulation project management.

There are 5 key components in the Visual*DSS* namely

- Multi domain Compute Model Manager
- Simulation and Data Manager
- Process Manager
- Report Manager
- Project and Workflow Manager

Multi domain Compute Model Manager bridges design (CAD) and CAE data. In this integrated environment, the BOM (Bill of Material) and product hierarchy are linked to the actual CAE data bridging the geometry and physics. The necessary design information such as the component geometry, topology, product tree, part identity and physical information such as material, gauge are directly imported and shared with the CAE model. The engineer can at any time query/search for the necessary metadata for simulation requirement. At the same time, the CAD parts are directly associated to the CAE model, for example, a fully built LS-DYNA frontal crash model can refer each CAD part and its design values for better decision making during the simulation cycle. Similarly the design engineer will be able to view and interpret the recommendation from the CAE engineer directly as the CAE results are attached to the product hierarchy itself for each load case.

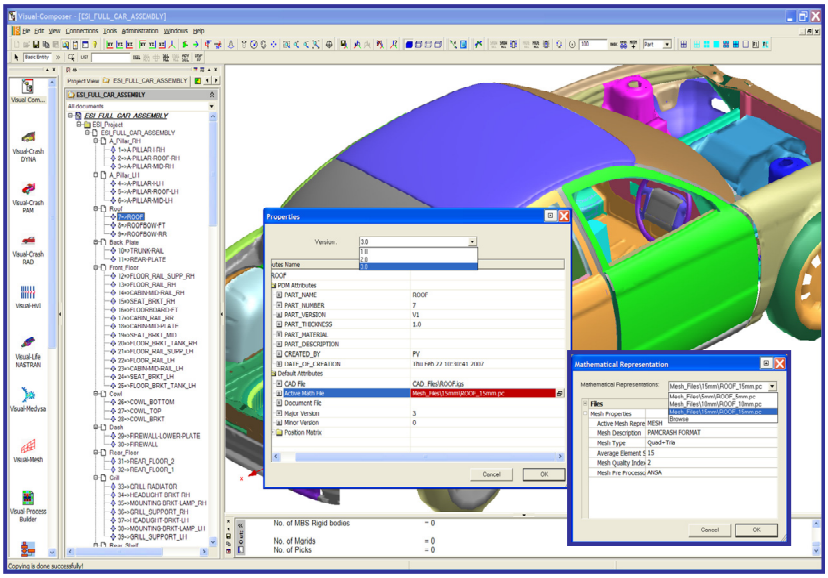

Fig 3: Visual*DSS* - Multi domain Compute Model Manager

Since the product hierarchy is same for other validation domains such as Safety, NVH, Durability etc, the engineers of the corresponding domains also will be able to share the CAE models accordingly. The corresponding solver entities are associated in each load cases. Also, across the domain, the engineers will be able to access the design, FE and simulation results, for example, if a stamping simulation (LS-DYNA or PAM-STAMP) result has to be considered on a component of crash model, the engineer can quickly capture it taking advantage of the multi domain model manager environment. A typical multi domain compute model manager work environment is shown in Fig. 3.

Simulation and Data Manager is the data base environment which stores various simulation data and distributes the data to the product development network (e.g. CAD, CAE departments, subsidiaries, suppliers). It encompasses all the necessary engineering, non-engineering, design, non-design data, workflow, projects, resources, corporate catalog containing customer requirements, reports, regulatory standard documents and more as distribution system to provide a global integration.

Process Manager is the CAE process manager which provides an integrated environment to capture best practices, build, audit, publish and automate various regulatory, standardized CAE

processes and best practices. This is typically handled by Visual-Process Executive and Visual-SDK[3, 4] in Visual*DSS*. The regulatory process templates and macros are stored in the data manager to be able to attach to particular load cases as rules by which the CAE engineer can execute the model building, report generation in faster methodology. Thus saving time in model building, generating more iteration, focusing on real product engineering to achieve simulation based designs. A typical process manager environment showing a side impact process automation template in Visual-Process Executive is illustrated below in Fig. 4

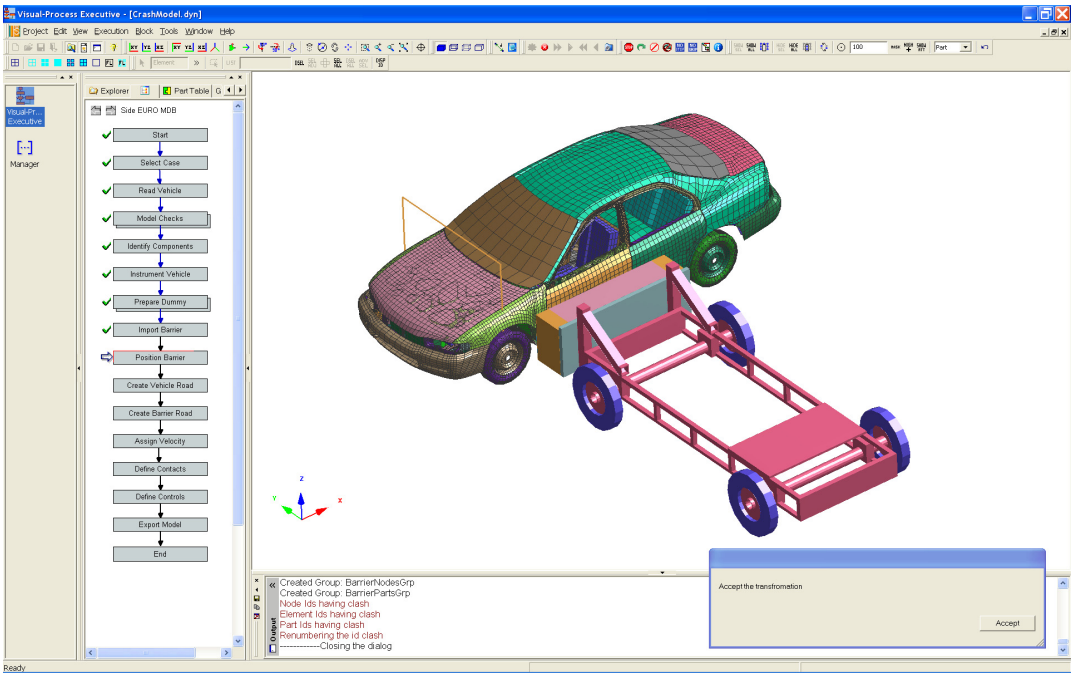

Fig 4: Visual*DSS* – Process Manager (Visual-Process Executive)

Report Manager is the post processing and reporting tool integrated in Visual*DSS*. Taking advantage of Visual-Viewer of Visual-Environment, this Report Manager is utilized to automate the post processing and report generation from the solver results, extract and store simulation decision values such as results curves, performance values (e.g. HIC, Failure criteria, Frequency, Structural modes). It is also extended to various report generator (specifically in web based Visual*DSS*) such as simulation comparison report, model comparison report, design update report and project report. This helps to analyze the stored simulation data based on the requirements and design parameters and come to better decision.

Project and Workflow Manager is the web based (thin client) Visual*DSS* which provides an integration of corporate project management tools (such as CRM, ERP), workflow management tools. Fig. 5 shows a typical web based Visual*DSS* where one can visualize PDM, CAE data and product hierarchy, design versions and other simulation parameters.

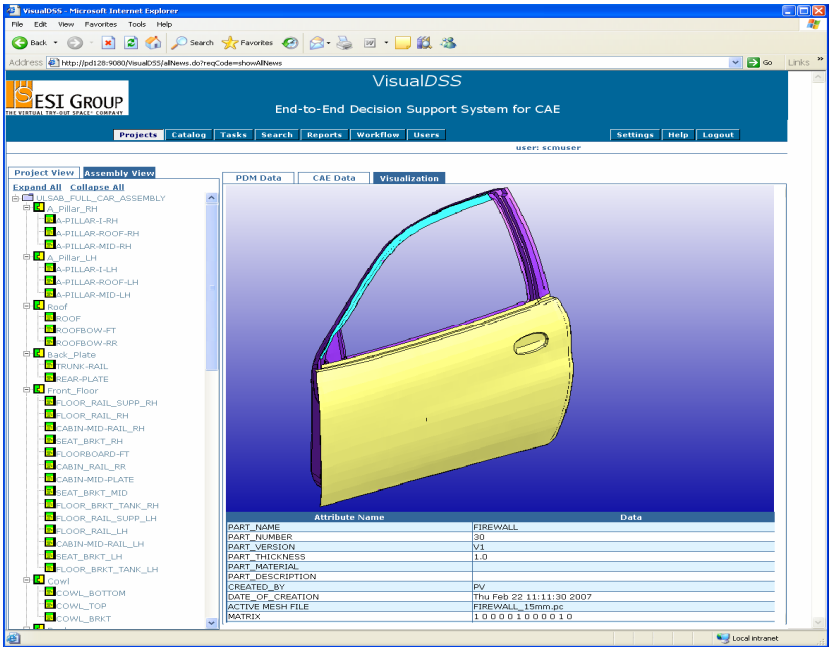

Fig 5: Web based Visual*DSS*

Most of the Managers, Supervisors activities are carried out in this environment. The supervisor can monitor, track the simulation progress. Managers can distribute or combine simulation activities, track the project process, assess resource efficiency and so on. Another important feature of Visual*DSS* is that it can integrate any of the five components as tasks of a workflow in the corporate workflow management tool. A typical workflow of LS-DYNA side impact model update with stamping output from PAM-STAMP in a workflow management tool is shown in Fig. 6

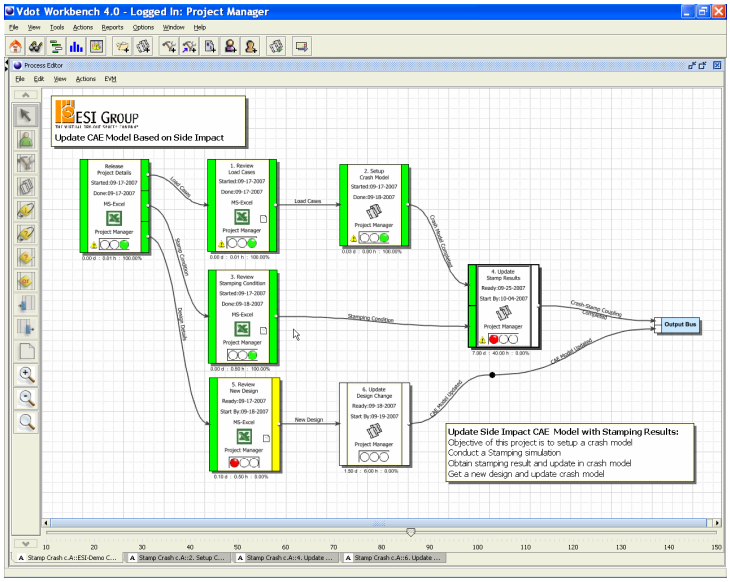

Fig 6: Visual*DSS* - Workflow Manager *(courtesy: Vdot)*

Benefits of Visual*DSS*

Because of single data model, Visual*DSS* provides a common ground for different disciplines in an integrated fashion. This helps to communicate simulation and design data across the domains saving time on non-valued added activities. The other key benefits of Visual*DSS* are as follows

- Faster design update from top to bottom
- Efficient communication of CAE recommendation back to design
- Data sharing and re-use of CAE model across the domain
- More and more iterations by automation, better decision making
- Enterprise wide integration allows faster product development

Summary and Conclusion

Today the simulation engineers keep the simulation data and knowledge in their local desktops. This makes the information unreachable to the needy in time. Though the corporate have well established service oriented information systems such as PDM, ERP and CRM, the CAE is not yet integrated into this enterprise services bus. The knowledge and experience the engineers gain while doing the simulation are not captured in a central location to reuse them for the future simulations for another engineer. A need for a system that integrates all these information is essential to achieve fast-to-market product development. Visual*DSS* is one such integrated simulation lifecycle management tools allows the enterprises to capture the simulation assets, manage them and reuse them to make decisions efficiently. As an enterprise engineering environment tool it is very well suitable for LS-DYNA simulations by linking to the PDM. It helps to achieve simulation based design by better decision making process for the ultimate goal of faster product development support.

References

1. Alain de Rouvray, et al., 2006. *Simulation Based Design.* EuroPAM 2006.

2. ESI Group, 2007. *Visual-Process, Visual Process Builder, Visual Environment* User Guides

3. Mike Keranen, et al., 2005. *Automating Instrument Panel Head Impact Simulation*. SAE World Congress, SAE2005-01-1221

4. Velayudham Ganesan, et al., 2004. *Fast New Methodology for Regulatory Test Simulation*. 8th LS-DYNA International User Conference