"Automating LS-DYNA Simulation Processes using SOFY's Rapid Application Development Environment RADE."

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Abstract

Since the first applications of Finite Element Analysis (FEA) in automotive design this technology has gone a long way to become a standard tool fully integrated in the design process of automotive industry. Strongly promoted by progress in mathematics, information and computer technology simulation results have today reached a level of accuracy comparable to physical testing. In parallel developments in software technology – ranging from CAD to graphical interactive pre- and postprocessing - have helped FEA to develop from a work performed by specialists into an industrial tool used by design engineers. Within a product design engineers often have to judge the performance of dozens of design variants by doing very similar Finite Element Analysises. This leads to the requirement to automate the pre- and postprozessing of FEA to reduce errors and turnaround times and to improve quality and productivity. This paper demonstrates how RADE – the Rapid Application Development Environment – of the commercial pre- and postprocessing package SOFY is used in industry to automate analysis processes from input creation to report generation.

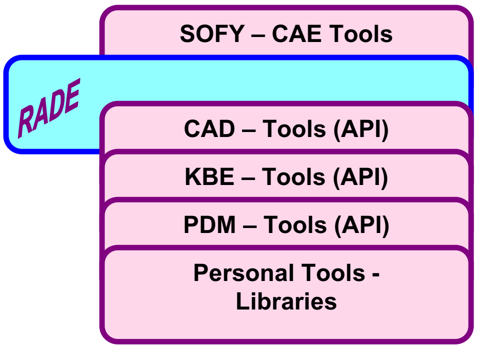
Introduction

Over the last decades Finite Element Analysis (FEA) has become an accepted tool in engineering design of many products reaching from space craft to house hold products. In the car industry FEA has been integrated so deeply in the design process that people even say that they have a CAE driven design process. Applications of FEA in car design include many disciplines like internal and external aerodynamics, static and dynamic structural analysis, crashworthiness design and occupant safety. In the design departments of major automotive manufacturers hundreds of engineers perform thousands Finite Element Analysis in the course of a year.

During the optimisation of a component or the complete assembly very similar configurations have to be analysed many times. In this context a strong demand to automate FEA process arises. The automation of the FEA processes will drastically increase productivity, reduce cost and turnaround times and increase quality through the implementation of best practice and company rules. Many users of FEA have made efforts in the last years to automate their processes either by developing process automation software in house or together with partners from the software industry.

RADE

Sofy Technologies strategic goal is to be a leading provider of such process management tools to support his customers product development efforts. For this purpose Sofy Technologies developed the products RADE and V-RADE in close co-operation with major automotive manufacturers. RADE stands for Rapid Application Development Environment and V-RADE is the visual and interactive version of RADE for non-programmers. RADE provides an integrated set of capabilities to capture, replay and develop robust CAE processes. RADE's interpreted language is simple and easy to learn and yet has the sophistication of contemporary object oriented languages. RADE provides access to all of SOFY's (SOFY is the pre- and postprocessor developed by Sofy Technologies) internal functions and is attachable and embeddable in any software that provides an Application Programming Interface (API). RADE is a nimble environment for CORBA compliant portable applications.



Setting up an automated Process with SOFY / RADE

When it is decided to automate a process with SOFY/RADE for a specific analysis like a static or crash analysis for a car body the user must first undertake a careful investigation of the full process from mesh creation to result analysis and report generation. To this end one would first examine his current conventional procedure of setting up the analysis by "hand". This would best be done by drawing a flow chart of the ideal process. Keeping in mind that it only makes sense to automate a CAE process if it is foreseeable that a number of variants of this process have to be performed this flow chart should include and support all foreseen branches, choices and variations that the automated process should later be able to handle. Such a flow chart for a standard "Seat Belt Pull Test" according to FMVSS standards is shown on the next page. At this points it is advisable to consider the implementation of "best practices", measures for assuring the quality of the process and company rules like naming or numbering conventions for the FEM model. Further the company practices and legal requirements for physical testing and result evaluation should be considered at this point to plan the according inputs for and outputs from the FE analysis.

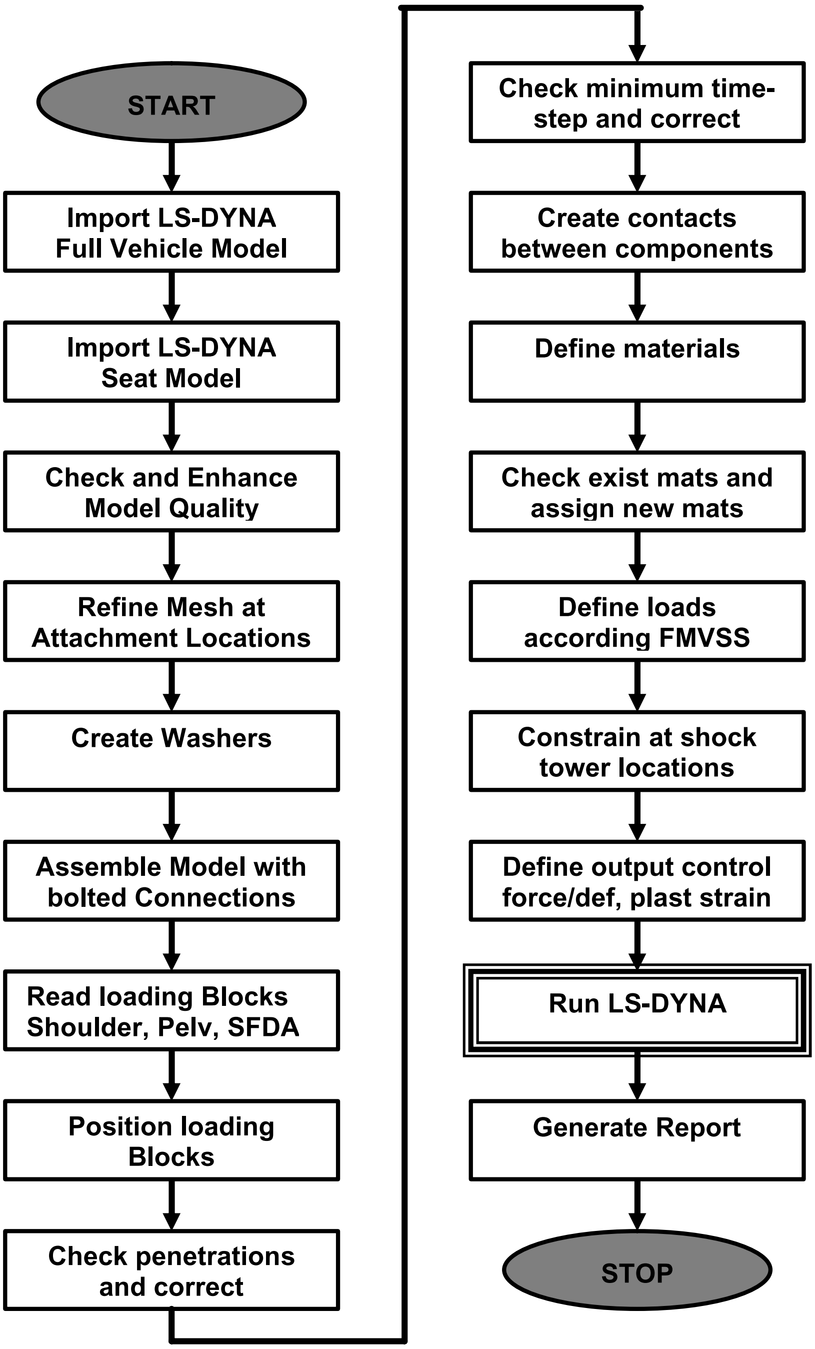
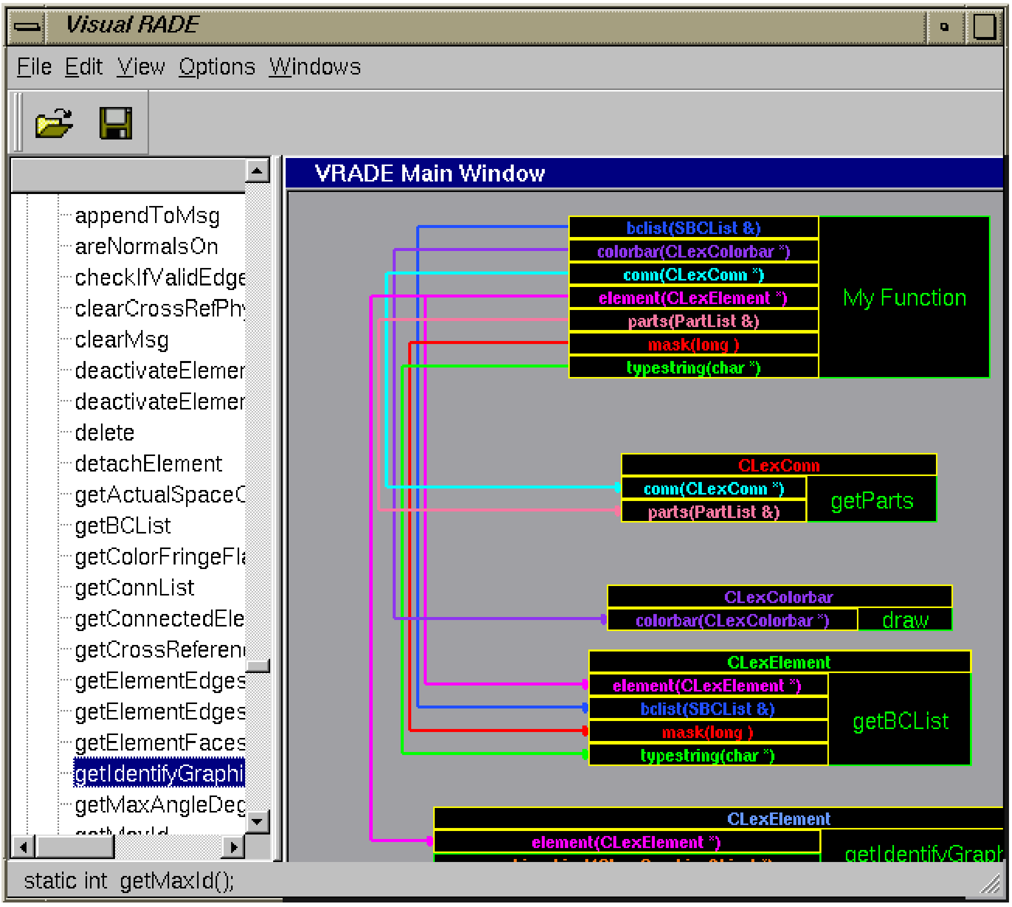

START
Import LS-DYNA Full Vehicle Model
Import LS-DYNA Seat Model
Check and Enhance Model Quality
Refine Mesh at Attachment Locations
Create Washers
Assemble Model with bolted Connections
Read loading Blocks Shoulder, Pelv, SFDA
Position loading Blocks
Check penetrations and correct
Check minimum time-step and correct
Create contacts between components
Define materials
Check exist mats and assign new mats
Define loads according FMVSS
Constrain at shock tower locations
Define output control force/def, plast strain
Run LS-DYNA
Generate Report
STOP

Figure 1: Flow chart for a seat belt pull test.

Once this flow chart is established - taking into account all the considerations listed above - it is advisable to perform the process one time using the pre- and postprocessor SOFY and to capture the input where possible. Then the full process can be implemented using RADE or V-RADE.

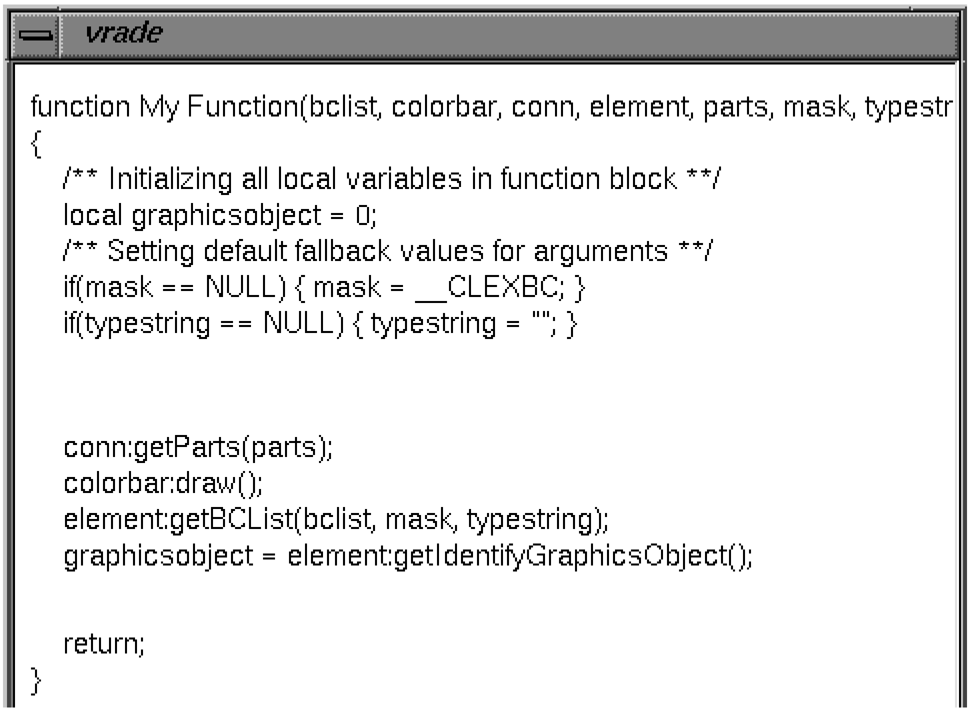


```
static int  getMaxId();
```

Figure 2: Programming with V-RADE.

Figure 2 shows the programming of a function - which might later be used for the automation of the process - using V-RADE. Figure 3 shows part of the equivalent RADE coding for this function.

When the whole process has been programmed with RADE or V-RADE the last thing to do is to add a “Process” button to SOFY’s menu bar. Under this button several processes can be arranged and started from there.



```
function My Function(bclist, colorbar, conn, element, parts, mask, typestr
{
   /** Initializing all local variables in function block **/
   local graphicsobject = 0;
   /** Setting default fallback values for arguments **/
   if(mask == NULL) { mask = __CLEXBC; }
   if(typestring == NULL) { typestring = ""; }



   conn:getParts(parts);
   colorbar:draw();
   element:getBCList(bclist, mask, typestring);
   graphicsobject = element:getIdentifyGraphicsObject();


   return;
}
```

Figure 3: RADE code for a function.

Running an automated process

Pushing the Process button in SOFY's menu bar (see Figure 4) will open a menu that displays all available processes.

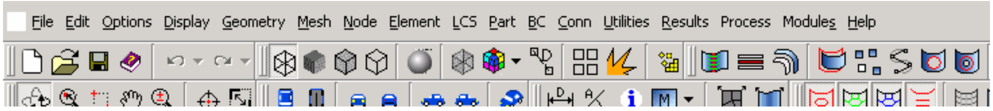
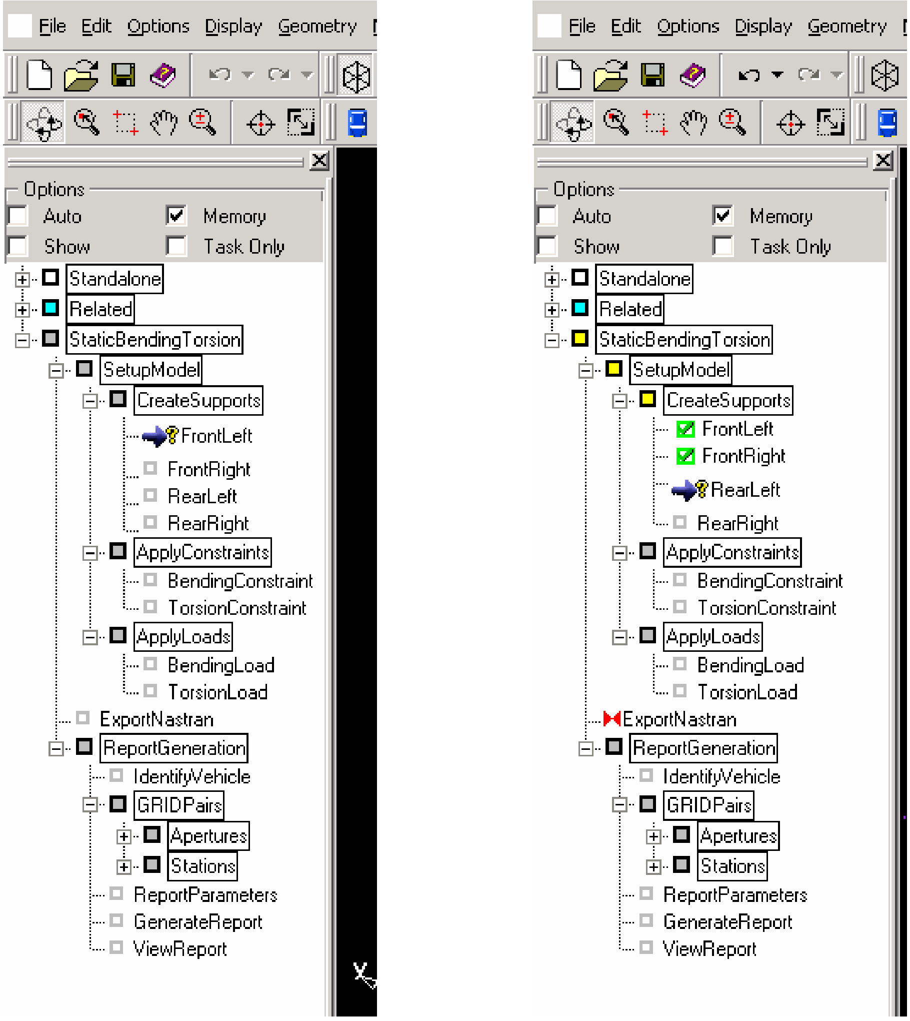


Figure 4: SOFY's menu bar with the "Process" button added.

After the selection of a process a new window will open at the left hand side of SOFY's screen. Figure 5a shows the initial process window for a static load case for a car body as an example.

When the process is started the software will go through the process step by step and display parts or locations where fixtures have to be created and boundary conditions, loads etc. have to be applied. Based on the process memory the program will propose for every step methods, locations or values as appropriate. The user can accept these proposals or apply changes for every step. Figure 5b shows how the software signalises every step that has been performed.

Figure 5a+b: Process window for a static load case.



Options

☐ Auto ☑ Memory

☐ Show ☐ Task Only

Once the input for an analysis has been completed in this way the user will write out the new solver input file and start the analysis. When the analysis is finished he will start again the process within SOFY and will be guided through the standard results evaluation for the case up to the point where a standard report compliant with company rules will be launched.

Due to the limitation to black and white still pictures I have not shown any pictures of the LS-DYNA model. These will be presented during the conference.

Summary and Conclusions

SOFY's RADE and V-RADE offer an easy to learn and to use way for automating LS-DYNA simulations from input generation to result analysis and report generation. This contributes to increased productivity and quality while reducing turnaround times and cost in the CAE driven design process.