IMPLEMENTING AN AUTOMATED PROCESS FOR UPDATING CATIA FILES FOR OPTIMIZATION PURPOSES

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ABSTRACT –
Achieving optimum performance for car components during multiple and complex crash scenarios, requires that simulation engineers examine various design aspects of component geometry. This is efficiently accomplished by identifying some of the parameters transferred from CAD files into the simulation model as design parameters and by varying them in a Design of Experiment (DOE). The design parameters are updated in each experiment and the task of transferring them back from the FE-environment to the CAD software has proven to be a challenging process. While demanding and time consuming, this step is mandatory as the design parameters between simulation and CAD need to be aligned to allow automatic component design update and subsequent optimization to proceed. This presentation shows a case at BMW of an automated process that achieves this initial update and transfer of design parameters from simulation to CAD software. This is accomplished through a process workflow that ensures the interoperability between different os-platforms.

1. INTRODUCTION

BMW's simulation engineers face the daily challenge of developing automotive components that are lightweight and at the same time meet precise and often stringent functional requirements when subjected to multiple and in many cases complex load cases, such as in crash simulations.
Changes made to the initial design either manually, supported by engineering experience and deep understanding of the problem, or through optimizations using parameters in the FE models (such as thickness and material of components or morphing parameters that change their shape) usually require a new design. CAD export from ANSA is not efficient for this purpose as the result may not meet design constraints. To overcome these inconsistencies and avoid back-and-forth cycles between construction and simulation, we faced the challenge of using CATIA parameters in CAD components directly as design variables in the optimization workflow in ANSA. CAPOS (Catia Parameter Optimization in the Simulation) describes this process, whose milestones are presented below, by means of a pilot project used to develop and tune the process itself in the field of crash simulation.

2. PROCESS REQUIREMENTS

For the CAPOS process to work, communication between FE-Environment-tool (ANSA) and CAD-Environment-tool (CATIA) must be established and the interoperability of the two underlying operating system platforms must be ensured.
An automatic transfer of the parameters from the CAD files to the simulation model is required. These are then defined as design parameters and varied in a Design of Experiment (DOE). The updated values in each experiment must be passed back from the FE environment to the CAD software: the alignment of the design parameters between simulation and CAD is mandatory to allow automatic component design update and subsequent optimization to proceed.
For the integration of the CAPOS process within the BMW environment it is then required that the tools for parsing and updating the CATIA parameters in the FE-Model closely communicate and exchange data with the Simulation data management (SDM) system, the BMW Automotive Portal internally named "CAE-Bench 2" (CB2).

As an integrated solution with access to the authoring tools and compute resources, SDM enables a fully automated management of assemble-, solve- and post-processing process, based on generated load case scenarios, as schematically shown in Fig. 1.

The FE-part to be optimized is contained in a "Sub Model" which is assembled in CB2 with the surrounding structure. For the process to run smoothly in an automated fashion, it is required that the updated part meet the same quality checks and modeling criteria as the original part (such as numbering conventions, contacts, sets, etc.).
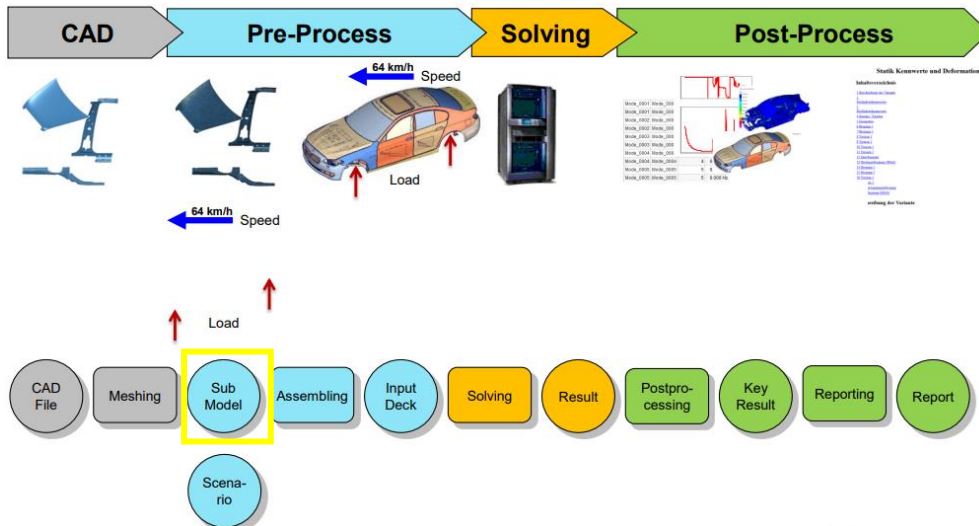

Figure 1 – CAE process chain in CB2

2. CAPOS PROCESS EXECUTION

The Capos process is executed by means of the Simulation Process, Data & Resources Management (SPDRM) software of BETA CAE Systems. It responds to requests made by the SPDRM Clients (user interfaces to the server) by creating, querying and modifying database records via the Beta Apps Launcher, shown schematically in Figure 2.

- The parsing of the design parameters and the update of CATPart is performed in CATIA, launched in a dedicated BETA Apps Launcher (Windows OS).
- The translation and meshing of the updated geometry are performed in ANSA, launched in another dedicated BETA Apps Launcher (Linux OS).
- Finally, the local output/save in SDM of the updated geometry is performed by a parallel ANSA session, launched in the user's host machine
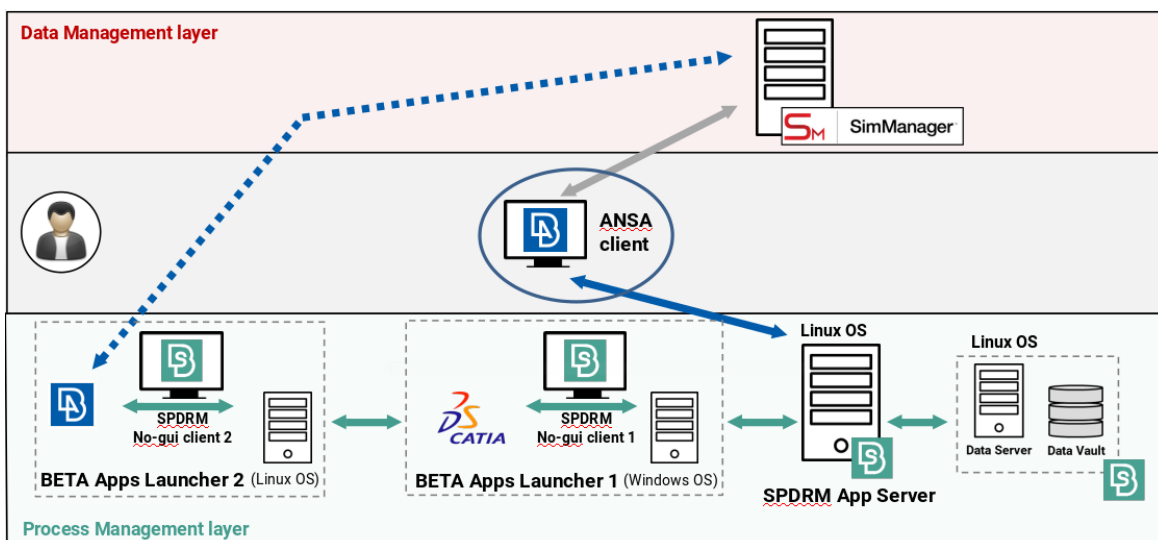

Figure 2 – SPDRM architecture

3. CAPOS PROCESS APPLIED TO A CRASH LOAD CASE

The CAPOS process has been used to optimize the rear door's side impact beam subjected to door impact (Figure 3 below). This load case scenario is simulated in CB2 with a process chain like that of Figure 1. The pilot project served to develop and test the necessary tools and their interactions with the SDM system to obtain an automated process in the context of LSDyna crash simulations, starting from a CATPart and arriving at useful DOE results for subsequent optimization (in this case performed with an external tool, Hyperstudy).
In the figure below the original (left) and the optimized geometry (right) are shown under maximum load. The optimized geometry has been proven to work better (no cracks) with a lighter structure (-360g).
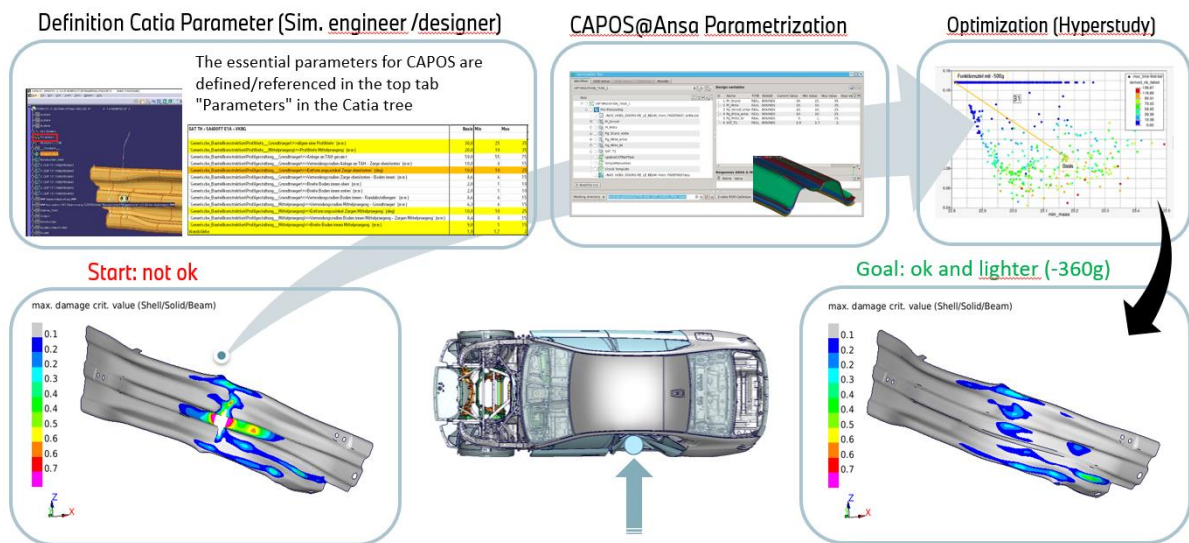

Figure 3 – Example of an optimization workflow using the CAPOS process

The steps needed to prepare the suitable ANSA session to run the DOE in an automated way, have been implemented as simple "User Actions" to:
- Import a Catia file in Ansa directly from the construction database
- Parsing the Catia parameters and defining them as design variables
- Setup the optimization task involving various actions (update of the CATPart, renumber of entities, checks, …)

Apart from these actions, proper merging of the CATPart with the FE-Submodel is an essential step in the process. This ensures on the one hand that only the main part is updated in the model and all other components and definitions (screws, glue, contacts, sets, …) are taken over by the original deck. On the other hand, it transfers all information about the Part, defined by the "User attributes" in the CATPart, to the FE-Model. This action is still performed manually by the user.
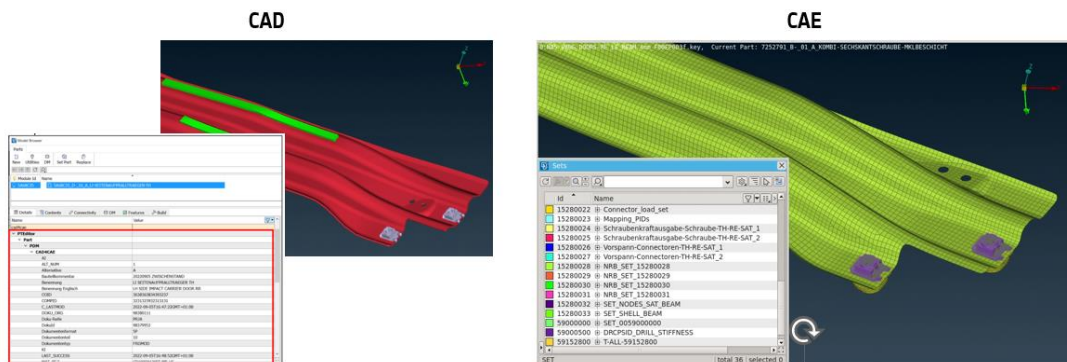
3.1 Update of the CATPart

The connection between ANSA and the SPDRM server is set within the CAPOS process by a script that executes various checks and actions:
- checks if ANSA is connected to SPDRM for process management
- collects the ANSA Part associated with the DVs and writes a CATIA design table text file from the active Design Parameters
- instantiates the SPDRM workflow passing the CATPart file, the design table, the starting ANSA database and the ANSA GUI layout of the parent
- collects the updated design in the form of a meshed ANSA Part
- replaces the original Part with the updated design

3.2 Stability of the Update of the CATPart

The CATPart update has originally been performed on the "Fertigteil_Solid", the CAD-body which is by default released and which contains all constructive details (like for example the embossing highlighted in Figure 5 on the left) and manufacturing information. This turned out to cause problems in Catia and therefore to excessively narrow the solution space.
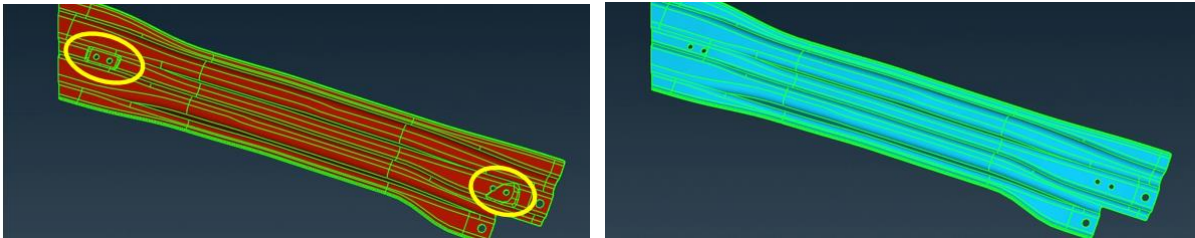

Figure 5 – Fertigteil_Solid (left), CAPOS_Solid (right)

The CATPart update process has been subsequently modified to perform locally on a simplified geometry called "CAPOS_Solid", if available in the CATPart. It has the same geometry as the Fertigteil_Solid, but without manufacturing and construction details.
For the pilot project this has been shown to improve the success rate of the DOE with 5 CATIA parameters from 45% to 82%.

4. CONCLUSIONS

A process has been developed that allows the use of CATIA parameters in CAD components directly as design variables in the optimization workflow within the BMW crash environment.
The process is quite stable and generalizable, and therefore suitable for a larger user base.
In the meantime, a new SPDRM server architecture is available, which guarantees greater stability and better communication between Ansa and Catia.