Prospects of integrating CAD and CAE in Simulation Data Management

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1 Introduction

Throughout the last decade, virtual product development has become vital to most if not all automotive manufacturers. Not only that CAE methods are now widely accepted by most engineers, today they are an integral part of the decision-making process and therefore a fundamental ingredient in order to being able to achieve ever shorter development times. Virtual product development has not only proven to be much more cost effective but also given the possibility to implement processes that are scalable so that numerous engineers can join and collaborate in the development of cars.

In order to address the issues of collaboration in virtual product development, PDM systems have been established and integrated with the CAD software used by the engineers. These PDM systems have been widely adapted for many years and are common practice for product design.

However, integrating CAE methods with PDM systems is challenging since the needs of CAE engineers and simulation tools are different in many ways from those of designers and CAD tools. These differences include:

- Handling of vast amounts of result data, both with respect to number of results and size of result data
- Different understandings and ways to deal with versioning and revisions
- The diversity of tools used for CAE processes
  - preprocessors
  - postprocessors
  - solvers
- The complexity of CAE processes
- The diversity of CAE processes.
  (Almost each discipline or kind of simulation has its own simulation process using different tools.)

In this paper we are going to present an approach of how to integrate the workflows and tools of CAD and CAE engineers. With this approach we try to address the following problems: dealing with existing PDM systems, a collaborative meshing process for converting CAD data to CAE data, common access to all CAD and CAE data for simulation engineers and designers, version management, and how to deal with multiple CAE solvers and disciplines. The feasibility of our approach will be demonstrated with a “Proof of Concept” implementation and the remaining issues and problems are going to be discussed.

2 Collaboration with CAD and CAE data

In order to scale up an engineering team to achieve fast progress on complex products it is essential that team members can share their product data they are working with. This is typically the domain of PDM systems for common product data such as CAD files or SDM systems for simulation related data.
Until today tools for engineers always require to load a certain amount of data from the file system or a database such that one can work with this data. The limitation is that only one person can work on the same piece of data at one time. Even though there have been some simple tools implemented that allow for simultaneous editing of simple text files by multiple users at the same time [1] there are no tools known to the author for more complex use cases. Especially no CAD software nor any CAE preprocessor.
The problem here is, that if we have for example one big file (piece of data) that is representing the whole CAD data of a product, only one engineer at a time can work on the design of that product. Therefore, the commonly used option is to divide the whole data needed to represent the product into

reasonable chunks of data. This is typically done by dividing one big product into many individual parts such that individual users can work independently on different parts without generating conflicts during the workflow. Almost any CAD software has adapted this practice and most CAE systems know the concept of parts and includes in order to achieve a separation of the data belonging to one product. Some of the CAD and CAE tools even support to load only certain parts or includes for editing, but the rest of the entire structure in a write protected mode such that users can see the surroundings of the part they are currently working on.
A key factor to achieve successful collaboration between larger groups of users is the granularity of pieces of data that people work on. The smaller the pieces of data are, the less probable it will be to run into conflicts during the workflow. However smaller pieces mean also that there are more individual sets of data (e.g. files) that have to be managed. Working with the whole structure in CAD and CAE tools becomes more challenging. One challenge regarding this is that CAD and CAE engineers usually prefer a different granularity of data sets for collaboration. For example the CAD product of a car might be separated into single files representing each one part of the complete assembly. However the CAE engineer prefers to group multiple parts into files each representing a section of the car (e.g. body in white, doors, hood, hatch, …) such that one has to manage less files.

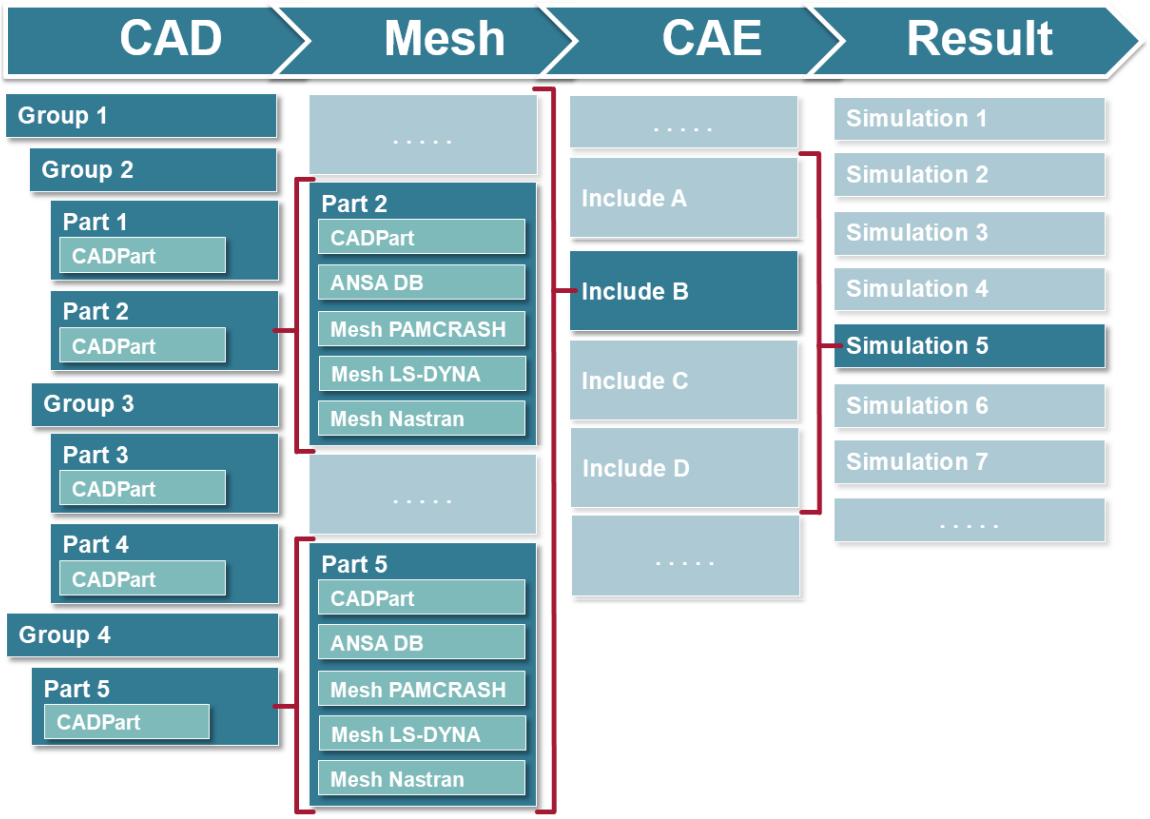

Fig.1: Granularity of CAD vs. CAE data

For a proof of concept project with AUDI we created a setup where CAD data are represented by individual parts which are stored in separate CATIA CADPart files. These CADPart files are managed in a prototypical implementation based on the SDM System LoCo. Design engineers were able to work simultaneously with the CAD data of a product using the “LiveMode”-feature of LoCo [2], see Fig.2:. While working on one part by opening it in CATIA this part is automatically locked such that others cannot work on the same part at the same time. The rest of the structure is loaded into CATIA as well, but not in design mode such that the part can be worked on while having an eye on the surroundings.
During the meshing process one or more ANSA database files are stored together with CADPart files of each part, keeping all the data that belongs to a part together. However using the extensive python capabilities of ANSA, opening and working with the meshes have been integrated for this prototype such that the whole structure can be opened completely, see Fig.3:.
In order to close the gap to the CAE world the parts belonging to one include can be assembled to solver include files of different formats. For the proof of concept at AUDI we used the same meshes to create solver files for PAMCRASH, NASTRAN and LS-DYNA. These solver files are linked directly in simulation

models within LoCo. Using the MSA feature in LoCo (Multi Stage Assembly [3]) the solver files are created automatically each time they are used in a simulation.
With this setup, each change in CAD data can easily be used in CAE simulations and CAD engineers can see without effort which simulations have been performed with specific revisions of their CAD files.

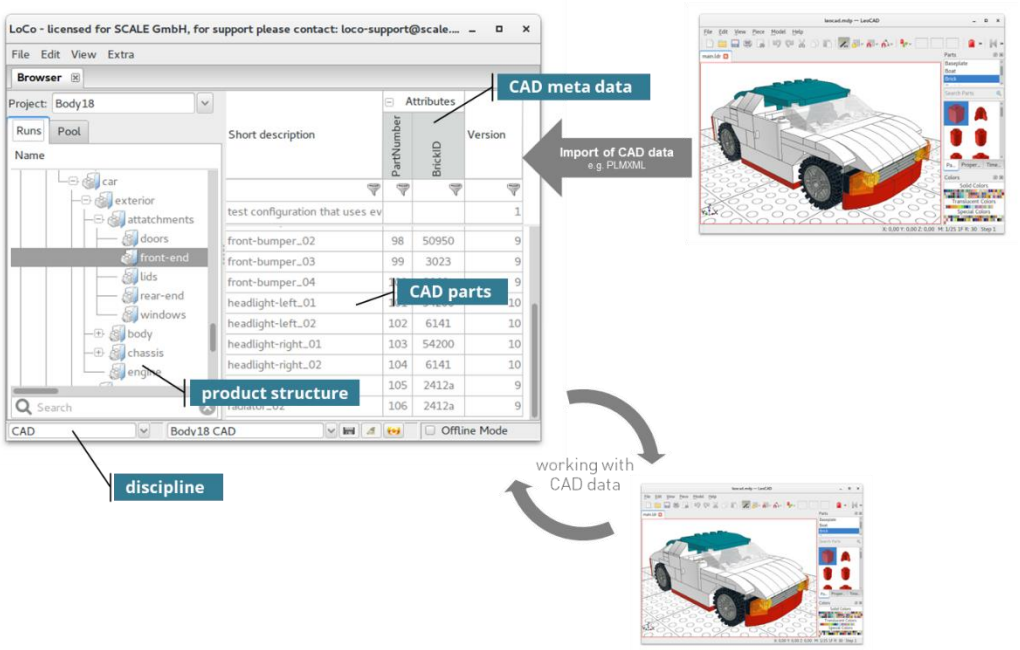

Fig.2: Importing and working with CAD data

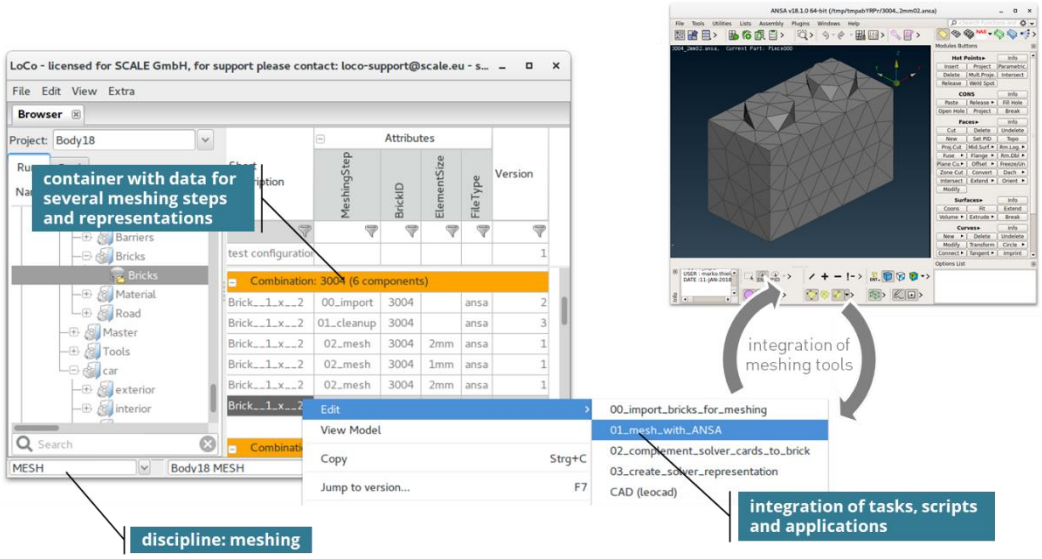

Fig.3: Workflow for meshing of CAD parts

3 Summary

Creating the proof of concept at AUDI we were able to show that it is feasible to have a tight integration between CAD and CAE engineers. With the proposed setup it is possible that engineers are aware of each change to the design and on the other hand it becomes easy to see which simulations have already been performed on certain revisions. This allows for a significant gain in productivity since changes are

propagated directly through the data management system to all team members independently if they are working on the design or any simulation discipline.

Although there are still many challenges, especially with the integration of tools such as CATIA or ANSA, we believe that this kind of tight integration between CAD and CAE will lead to a truly effective virtual product development process.

4 Literature

[1] Etherpad Foundation, "Etherpad," 16 09 2018. [Online]. Available: http://etherpad.org/.

[2] R. Bitsche, M. Thiele and T. Landschoff, "Recent Developments in LoCo - Instant Collaboration in Simulation Data Management," in *11th European LS-DYNA Conference*, Salzburg, 2017.

[3] M. Thiele, A. Saharnean and D. Rentsch, "LoCo – Multistage Assembly with a wheel generation process example," in *LS-DYNA Forum 2016*, Bamberg, 2016.