TEAMCENTER – ANSA INTEGRATION

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ABSTRACT – The different phases of simulation-driven product development generate significant and increasing amounts of diverse data whose loose management leads to error prone procedures that delay crucial decisions. Integration of the various CAE disciplines in a common PLM environment will help enhance data & human communication, accelerate the PLM process and increase the impact of simulation on all product development phases.

Existing PDM/PLM environments do not have the specialized integral tools required for the completion of CAE work; after all, such tools were not designed having CAE workflows in mind. Subsequently, they have to rely on external software for the preparation, verification and execution of CAE analyses.

To address the needs of today's Automotive Industry, SIEMENS PLM and BETA CAE Systems S.A. have taken the initiative to bring together Teamcenter and ANSA and offer an attractive solution that combines the efficiency of these well established applications in the PDM and CAE fields respectively. Teamcenter – ANSA interaction is facilitated through PLM XML files: a file that describes various aspects of the vehicle is exported from Teamcenter in PLM XML format, along with the associated product data. PLM XML file & associated data serve as input to ANSA. In turn, ANSA performs all required pre-processing actions based only on the information residing inside the PLM XML file. Finally, ANSA reports the result back to Teamcenter again through PLM XML.

This paper presents the framework within which Teamcenter and ANSA interact and provides some illustrative examples of typical use-cases that are currently covered by this interaction. Finally, the application of PLM XML based communication to the build-up process of a ready-to-run solver input file is discussed.

Development of Teamcenter – ANSA interaction is an ongoing process. It is expected that the results of this collaboration will serve the CAE community as an "out-of-the-box" solution for CAE model preparation.

TECHNICAL PAPER

1. INTRODUCTION

In recent years, the need to satisfy diverse consumer demands has forced vehicle manufacturers to create *better*, *safer* and *greener* cars. This has inevitably impacted all phases of vehicle product development, increasing the complexity at the design, validation and manufacturing stages.

CAD has elevated its role from a traditional mechanical design *tool* to a major product definition *process*. Evolution of 3D CAD applications has helped designers to produce and handle large numbers of component variations in shorter times. Furthermore, design itself was improved by Product Data Management (PDM) applications, who were the first to receive and support the CAD complexity by introducing efficient data management, versioning and configuration methods.

The use and importance of Simulation is elevated as well. Mirrored on CAE, the demand for more vehicle models with more variations and options, satisfying tighter regulations and
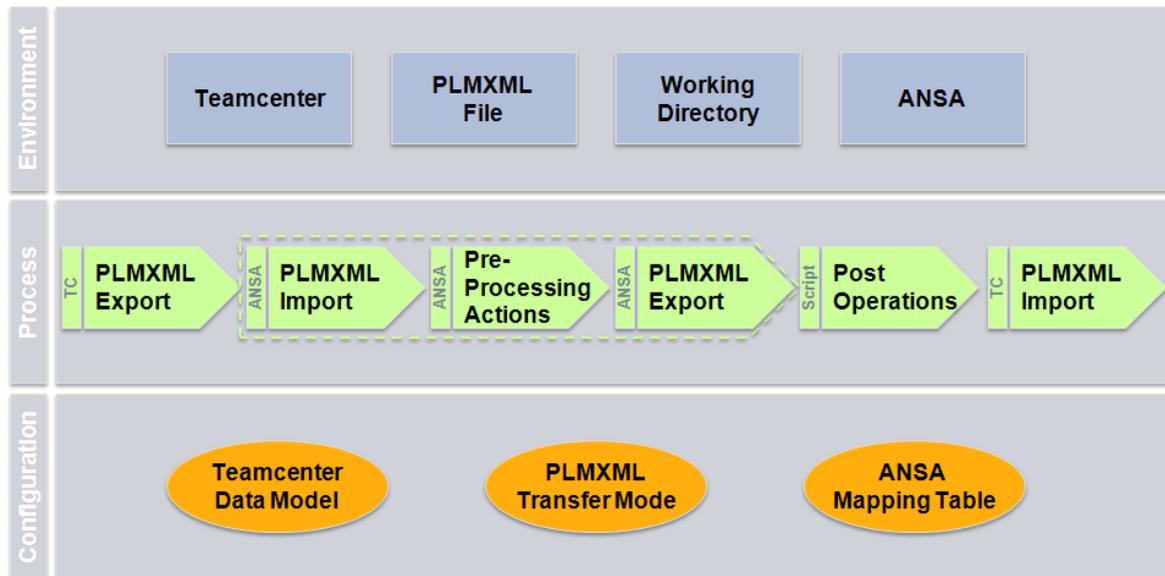
Figure 1 – The framework of Teamcenter – ANSA interaction

prepared at shorter time-to-market intervals, translates to an increased number of credible simulations in shorter times and at reduced cost. Simulation now plays an active role in the identification and definition of vehicle properties in early design stages so as to accurately predict vehicle behavior and assist decision making. Furthermore, the number of specialized simulation methods for various disciplines has increased significantly and it is a challenge for the CAE process to ensure that all disciplines work on the same state of up-to-date model data.

CAE process usually starts with the gathering of information related to the simulations that will follow. This information consists of the vehicle product structure and the related CAD & meta-data, extends to simulation scenarios and finally covers simulation results and post-processing evaluation reports. Since the bulk of this information is already handled by PDM systems, it would be beneficial to communicate it to the CAE environment in order to serve downstream processes. In this work we present an approach to bring CAE in close collaboration with a PDM environment, where actors are Teamcenter & ANSA and key role is given to PLM XML files that facilitate the communication between the two applications. The motivation is to accelerate the PLM process, increase confidence in CAE and enforce the impact of simulation throughout the vehicle development cycle.

2. THE FRAMEWORK OF TEAMCENTER – ANSA INTERACTION

Figure 1 depicts the three blocks that set up the framework of Teamcenter – ANSA interaction; these are the *Environment,* the *Configuration* and the *Process*. In the *Environment* block we distinguish Teamcenter as the application that handles the PDM information and ANSA as the pre-processor that is called to execute CAE related actions. The means to facilitate the information exchange between the two applications are a Working Directory, into which data are placed, and a PLM XML file describing the content of these data.

The configuration actions that need to be taken in each application in order to enable their communication are shown in the *Configuration* block. On Teamcenter side, we first define a *Data Model* that will identify ANSA as an external tool and make it directly accessible. Then, again in Teamcenter, we define a new PLM XML *Transfer Mode* to dictate the rules that control the amount and depth of product information that will be extracted from Teamcenter and will be included in the exported PLMXML file. Finally, this time on ANSA side, we need to create a *Mapping Table* to define the correspondence between Teamcenter and ANSA

keywords, so that ANSA will know how to act when such information is communicated. As the list of dataset types used in Teamcenter varies among OEMs, the PLM XML Transfer Mode and the ANSA Mapping Table need to be tuned *per OEM*.

A key point regarding configuration is the following: Teamcenter – ANSA interaction aims to cover a number of typical CAE use cases. These can be simple cases such as CAD-data translation and batch meshing, or cases of higher complexity such as the full vehicle assembly with connections, the handling of component updates, the reuse of common content, the build-up of ready to run solver input decks, and others. Since every use case has a different starting point and requires different pre-processing actions, an *easy* solution would have been to use a dedicated PLM XML Transfer Mode for each use case and have ANSA read/act differently depending on the use case at hand. However, by placing more *intelligence* to the pre-processor side, we have managed to cover all use cases using a *single* PLM XML Transfer Mode, thereby minimizing the need for extensive configuration on the Teamcenter side. Our aim is to standardize the amount and level of information that is exchanged between Teamcenter and ANSA, as well as the actions that Teamcenter and ANSA will take during this interaction, in order to cover as many use cases as possible.

The last building block of the framework gives an overview of the interaction *Process*: It begins in Teamcenter by exporting a PLM XML file and related product data into the working directory. ANSA in turn is called to run, read the PLM XML file and proceed to the required pre-processing actions using the data residing in the working directory. The actions that ANSA will follow are inherently dictated by the contents of the PLM XML file. In the end, ANSA will export a PLM XML file describing the modifications that were applied to the data and of which Teamcenter needs to become aware of. Post operations can follow, if necessary, and finally Teamcenter will import the newly created PLM XML file and proceed to updating the product information.

It is worth noting that the *same* process is applied for *all* use cases. This relieves users from having to know *what should be done* in each use case and leaves all actions under the full control of the pre-processor. Moreover, users have the choice to start the pre-processing actions either directly from Teamcenter or manually from the working directory. This latter characteristic allows Teamcenter – ANSA interaction to become *multisite*, as the contents of the working directory can be packed and transferred from the OEM to a Supplier's site. Suppliers in turn will carry out the pre-processing actions off-line and deliver the modified data and the respective PLM XML file to the OEM, to be placed back into the Teamcenter database.

3. PREPARATION OF PRODUCT DATA FOR CAE WORK

In the usual case, the product data representing a new vehicle are brought into Teamcenter directly from CAD. The product structure is at this stage identical to the CAD structure and covers all possible vehicle variations & options. For these reasons this structure is usually called *the unconfigured structure* and is evidently not suitable for CAE work. Hence, the CAE engineer needs to take some actions inside Teamcenter in order to *trim down* the unconfigured structure, remove redundant information and derive a new, discipline dependant, *configured structure* that will be used by all downstream CAE processes and, of course, by ANSA.

Figure 2 gives an outline of the data preparation process. The first step for the derivation of a CAE-ready configured structure begins in *Product Structure Editor (PSE)*. Inside PSE, the original CAD structure is filtered based on a set of *Variant* and of *Revision* rules. The former rules dictate *which* components are used in a specific vehicle variant (e.g. sedan, saloon etc) and the latter *which* CAD revision (version) of each component is to be used for the CAE evaluation. This filtering gives a structure that is regarded *configured* in the sense of the *components* that it contains, but it is still not suitable for CAE work. The final step of the preparation is achieved in the *CAE Structure Editor (CAE SE)* with the aid of *Structure Maps.*
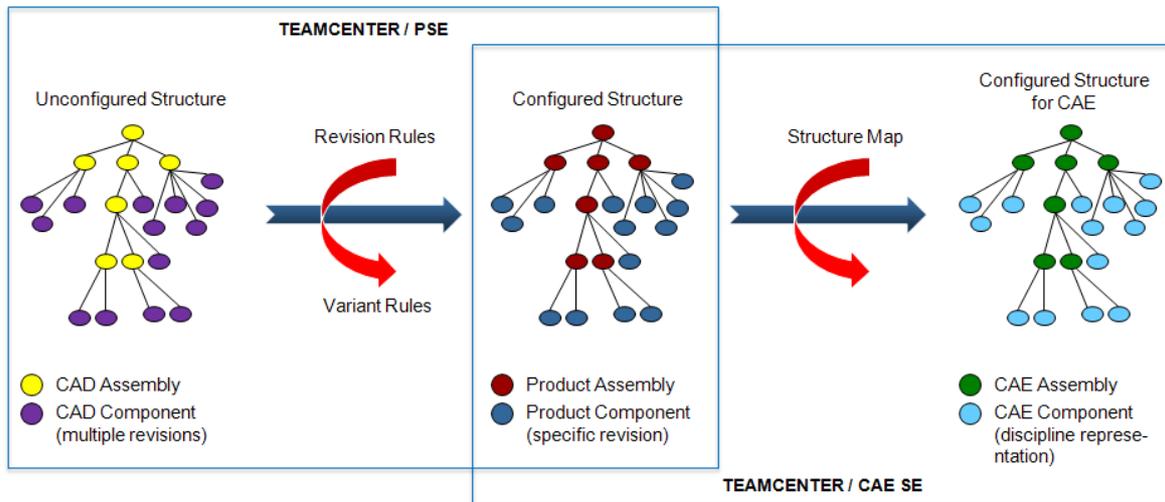
Figure 2 – Preparation of product data for CAE work in Teamcenter

A Structure Map is a set of instructions to transform an input product structure into a CAE product structure, suitable for a particular discipline. For example, a Structure Map for Crash analysis would dictate the meshing characteristics or FE-representation that the components should take in order to prepare a model for crash analysis. When the desired Structure Map is applied to the incoming product structure, the resulting CAE-ready configured structure can be exported to ANSA for pre-processing.

4. TEAMCENTER – ANSA INTERACTION POINTS

The interaction points between Teamcenter and ANSA are shown in figure 3. The first and simplest interaction point refers to *Component Meshing* and covers the translation of the product CAD-data into the native ANSA format and the subsequent Batch Meshing of the components according to the directions given in the PLM XML file. The derived ANSA file for each component is placed back to Teamcenter.

The cases of building a sub-assembly from its components and the building of a complete vehicle assembly from its sub-assemblies are covered in the second and third interaction points respectively. The difference among the two refers to the way ANSA handles the connectivity information. In the former case ANSA treats every sub-assembly in a singular fashion, realizing only its *internal* connections, i.e. the connections among its components. In the latter case it is assumed that all sub-assemblies are properly connected, so ANSA realizes only the *external* connections between the sub-assemblies. It is worth noting that,
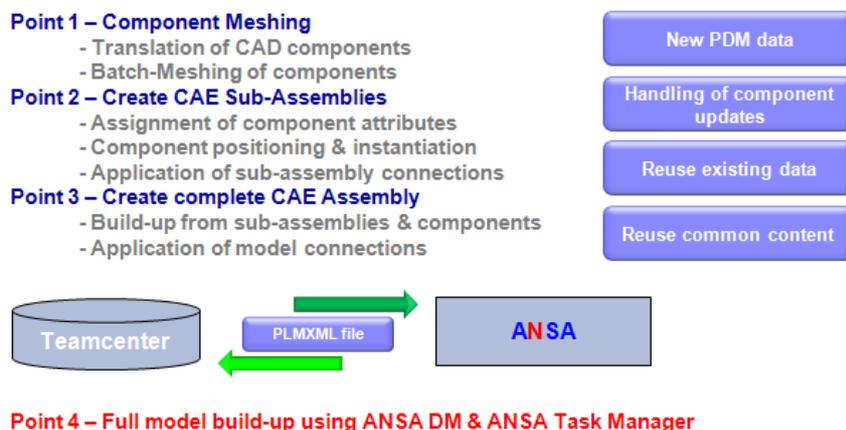

Figure 3 – Teamcenter – ANSA interaction points

in both cases, if the connectivity information is missing, the CAE engineer can easily create it in ANSA. When ANSA exports the PLM XML file back to Teamcenter, a new item containing the connections is automatically created.

All above interaction points use a configured CAE structure, the respective data and the TC exported PLM XML file as a starting point for all ANSA actions. Upon completion, the CAE engineer has the option to save the ANSA result in Teamcenter either as a monolithic file, containing the complete assembly, or on an individual component level. Moreover, the CAE engineer does not have to concern or divert his process in any of the interaction points in order to handle component updates, reuse existing data or accommodate content that is common between assemblies. These cases are all handled inherently either by Teamcenter or by the intelligence put in the PLM XML ANSA reader.

Once a complete vehicle assembly is built, the fourth point extends the Teamcenter – ANSA interaction to the preparation of a ready-to-run FE-model. In this case ANSA utilizes the functionality of ANSA DM and ANSA Task Manager to create an input file for the analysis at hand.

5. A SIMPLE USE CASE: CAD-DATA TRANSLATION & BATCH MESHING

We will now describe the simple use case of CAD-data translation & batch meshing assuming that the PDM data of a complete vehicle reside in the Product Structure Editor (PSE), as shown in Figure 4a. For a clearer view of the process we isolate the small assembly of the instrument panel, shown in Figure 4b, and place it under the control of the CAE Structure Editor (CAE SE) in order to build a CAE-ready configured structure.
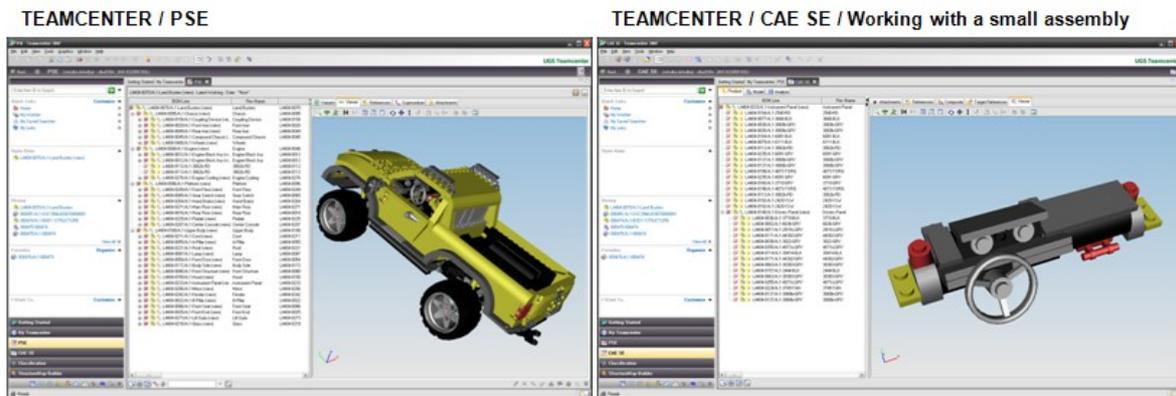

Figure 4 – (a) PDM data of a complete vehicle, (b) instrument panel sub-assembly

In figure 5 we see that the instrument panel contains symmetric as well as multi-instanced components. These components are defined in their CAD form only once in the PDM system and their actual locations are reproduced based on transformation matrices.
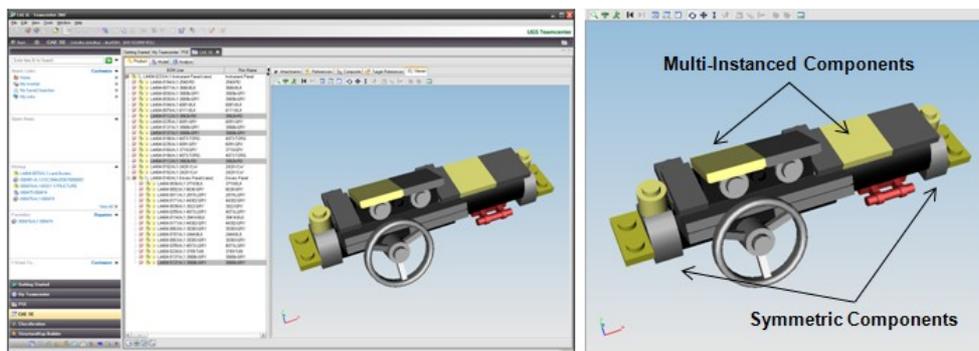

Figure 5 – Symmetric & Multi Instanced components

The application of a discipline specific structure map to the sub-assembly will inherently dictate the way these components should be meshed by ANSA. At this stage, if other engineering data are available (e.g. properties, materials etc), they would populate the respective columns appearing in CAE SE (figure 6).
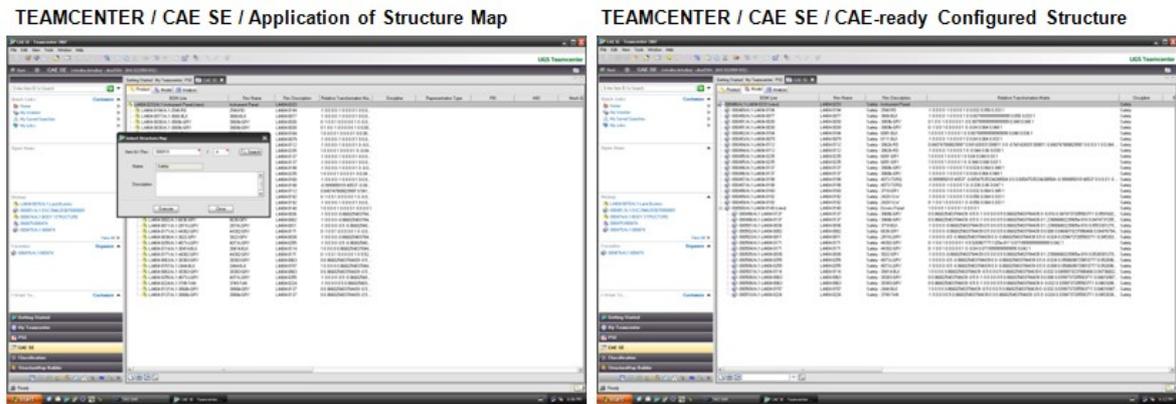

Figure 6 – Application of Structure Map and derivation of the CAE-ready configured structure

The export process (figure 7) will place a PLM XML file containing all information regarding the configured structure as well as the corresponding CAD files of the components comprising the instrument panel into the working directory that facilitates the data exchange.
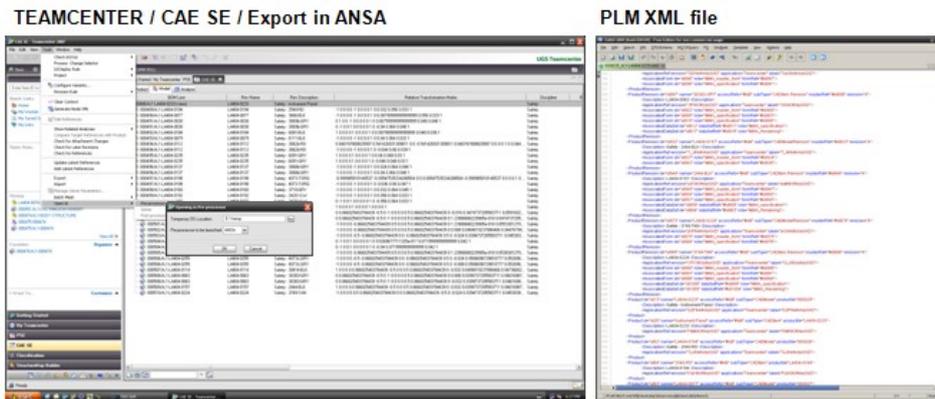

Figure 7 – Export of configured structure in pre-processor

ANSA is then launched, imports the PLM XML file and begins to translate, position and instantiate every component. Subsequently, when all components are ready, the Batch Mesh Manager is invoked, with a session populated by the components of instrument panel and with meshing & quality parameters based on the representation decided in the structure map.
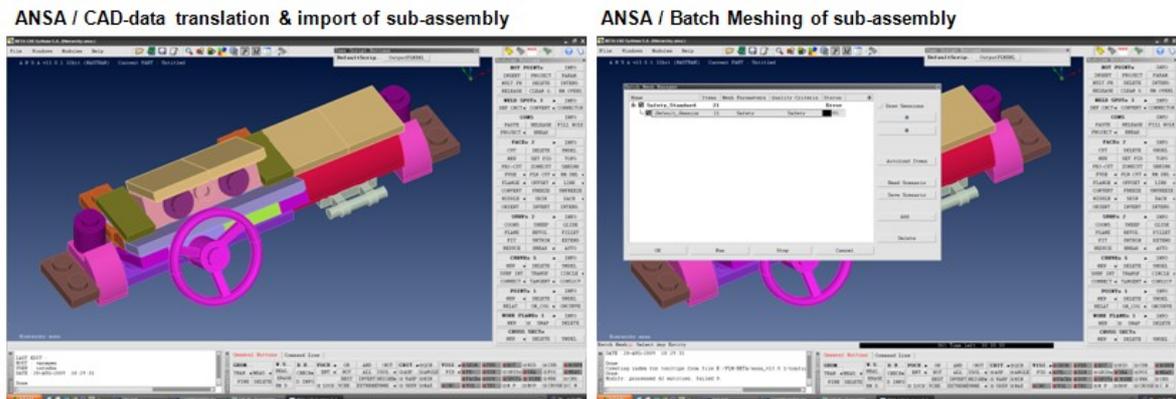

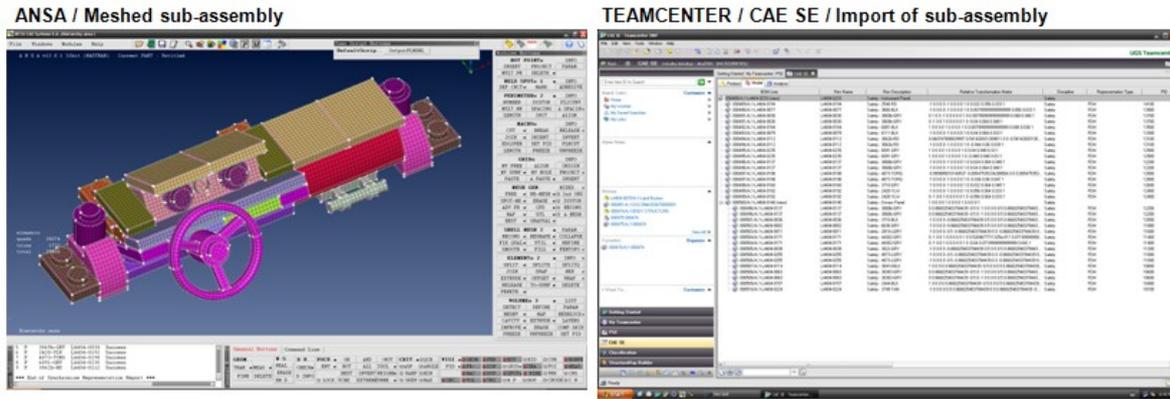Figure 8 – Positioning, instantiation and batch meshing of components

Figure 9 – Import of sub-assembly back to Teamcenter

The CAE engineer can modify any of the CAE properties of the components at any time. When finished, the PLM XML export process from ANSA will: (a) store the components in ANSA format, (b) store a top-level single assembly file, and (c) produce a PLM XML file containing all modifications.

Teamcenter is then importing the PLM XML file, attaches the corresponding ANSA files to the components of the instrument panel and updates the product structure accordingly. The next time that the instrument panel, or any of its components, is called to participate in the build-up of a configured CAE structure, the process of CAD-data translation will not be repeated, whereas the batch meshing process will be repeated only if the existing mesh cannot satisfy the requirements of the discipline at hand.

It is also worth mentioning that the component meshing process is always accomplished in the context of the sub-assembly. Hence the transformation matrices and even available point connections are considered at this stage. Once this task is done, the component meshes are stored back in Teamcenter in their original component position to ensure reusability in other sub-assemblies.

6. THE HANDLING OF CONNECTIONS

The connectivity information that accompanies a structure is usually exported from the CAD system and resides along with the other PDM data in Teamcenter. This information can have various formats, but within the framework of Teamcenter – ANSA interaction, we have agreed to use the standardized form of Master Connections File (MCF) as the preferred way of storing and communicating connectivity information.

When a *connections* item of MCF form is included in a configured CAE structure that is exported from Teamcenter, ANSA will automatically identify these connections. The connection type is dictated inherently in the MCF file. The CAE engineer can now proceed to the realization of the connections. Moreover, if the CAE engineer uses ANSA to create or modify connectivity info, these modifications are reflected back to the respective connections item in Teamcenter.

Figure 10 presents a case of a configured structure of a small sub-assembly that will be exported from Teamcenter to ANSA for the purpose of realizing the connection between its components. The connectivity information is given in a *connections* item in MCF form. There are two possibilities regarding the contents of the *connections* item: (a) to contain the connections for just this small sub-assembly, or (b) to contain the connections for the complete vehicle.

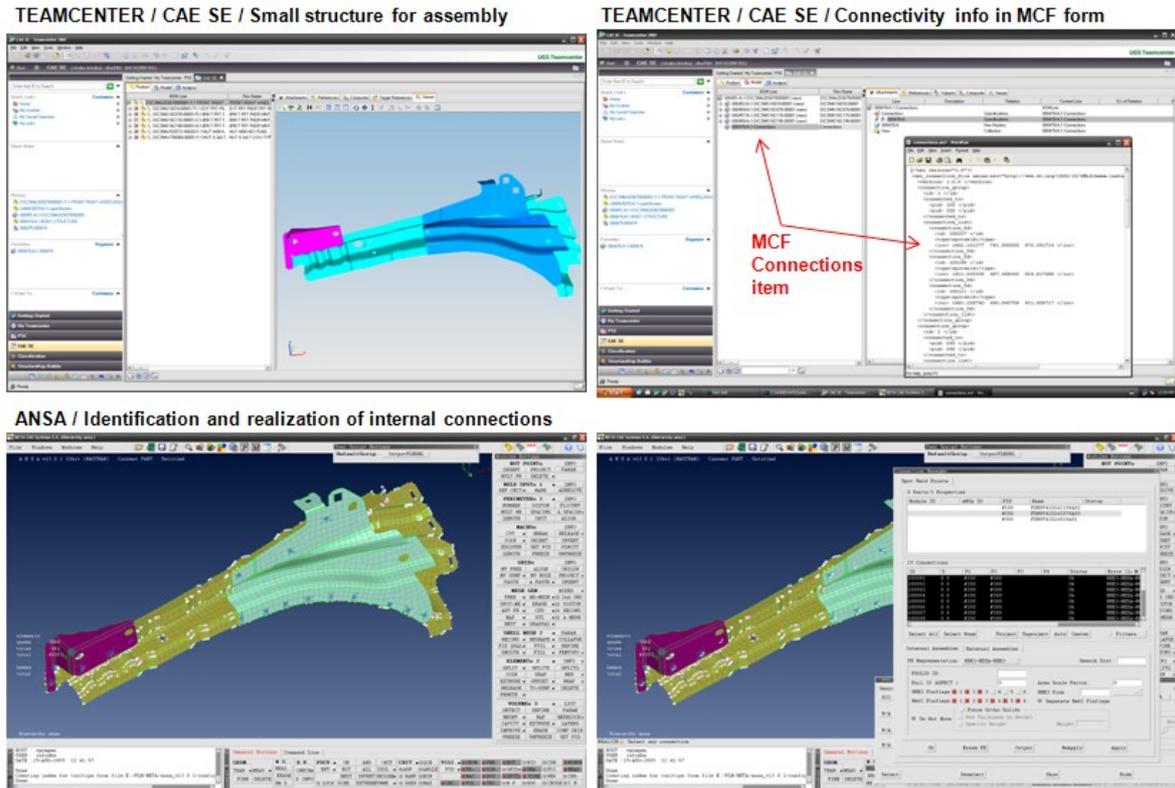In either case, when this structure is exported to ANSA, ANSA will identify and process *only*

Figure 10 – Handling of connections

the connections that are *internal* to the sub-assembly and create an MCF file containing the *external* connections. ANSA exports back to Teamcenter a monolithic file ANSA containing the properly connected sub-assembly and its corresponding connectivity information, as well as the created MCF file.

When the above process is applied on the complete car, then all connections are considered, since now they are *internal* to the vehicle top-level assembly.

7. FULL MODEL BUILD-UP USING ANSA DM & ANSA TASK MANAGER

Teamcenter – ANSA interaction has so far covered the build-up of a vehicle assembly, starting from its original CAD structure, stored as PDM data, and moving on to the suitable CAE configured structure that is exported to ANSA for pre-processing.

This complete vehicle assembly corresponds, in ANSA CAE language, to the common model. The common model defines the physical model that will participate in the analysis. It consists of all the components, connections, connectors and mass-trim items that are common to all disciplines. The common model is stripped of any solver specific features; it is, however, ready to adopt any form suitable for the analysis that will follow (figure 11).

We can now benefit from the existence of the common model and enhance Teamcenter – ANSA interaction for the purpose of deriving the *solver common model*. The solver common model dictates how the common model should be transformed in order to become meaningful for the particular CAE analysis at hand. In this sense the solver common model may be essentially the same for all analyses under the same CAE discipline and can be seen as a link between the common model and the actual solver load case that follows.

For example, if we would like to perform front impact analysis using LS-DYNA, we need to read the common model, give the suitable representation to model connections and
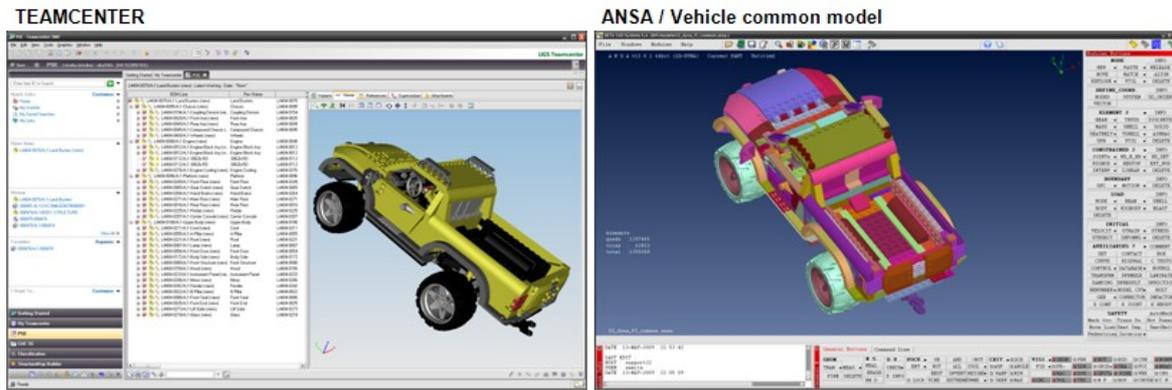
Figure 11 – The common model

connectors, add the necessary mass trim items, define the output requests and verify that the model is indeed valid for LS-DYNA.

The preparation of the solver common model is achieved by utilizing two integral parts of ANSA: the ANSA Data Management and ANSA Task Manager. ANSA DM lies in the background and provides all the required auxiliary and library items, while ANSA Task Manager reflects all distinct modelling actions that must be followed for the preparation of the solver common model. These task templates are also stored in ANSA DM. In figure 12, ANSA loads the common model exported from Teamcenter, assigns the solver common model task and executes its actions. The result is communicated back to Teamcenter for storage.
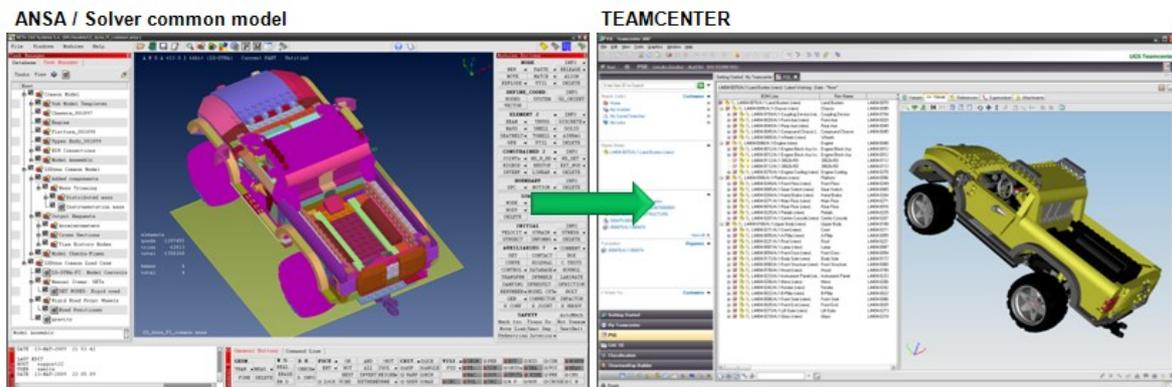

Figure 12 – The solver common model

In a fashion similar to the above, the solver common model can be exported from Teamcenter for the purpose of preparing a solver input deck. All that is now missing is the application of the specific loadcase(s) that need to be analyzed. A loadcase contains all solver definitions that make the model suitable for the investigation of a standardized or OEM-specific loading scenario. ANSA Task Manager, having ANSA DM always in the background, will apply the desired loadcase(s) and proceed to the output of a ready-to-run file that can be submitted for solution (figure 13).

The described approach to the build-up of solver input files exploits all benefits of the integral functionality of ANSA Task Manager. All actions leading to the final output can be defined by CAE experts and, executed in a stepwise fashion, can be repeated by inexperienced users and help capture and diffuse knowledge among members of the same group. Moreover, Task templates are repeatable, can be used with different sets of data and can easily
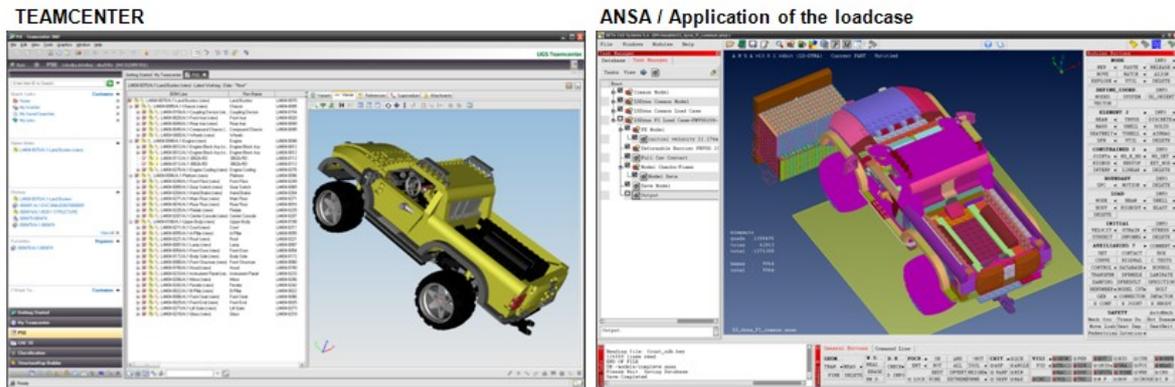
Figure 13 – Application of the loadcase

accommodate changes in model parameters. Finally, with all items under the control of Task Manager, the identification of inter-dependencies among modelling actions and the subsequent resolution of conflicts safeguards model integrity.

8. CONCLUSIONS

Teamcenter – ANSA interaction is an attempt to bring the worlds of PDM/PLM and CAE closer and satisfy the need for faster, efficient CAE workflows, able to actually impact product development.

The interaction framework requires minimum configuration for the two applications. Data exchange is facilitated through a common working space and a single PLM XML file describing the product structure and the content of the exchanged data. At the beginning of the process, the data and the PLM XML file are exported by Teamcenter. ANSA is then importing the PLM XML file and performs the required pre-processing actions on the product data. In turn, a PLM XML file is exported by ANSA and subsequently used by Teamcenter in order to bring the modified data back, update the product information and accommodate the pre-processing actions.

A major advantage of the PLMXML approach is that *no interface utility* (translator) is required to establish the communication between Teamcenter and ANSA. Hence the two applications can be released independently of each other.

Teamcenter – ANSA interaction points include CAD-data translation and subsequent batch meshing, the build-up of sub-assemblies and the build-up of a complete vehicle assembly. In combination with ANSA DM and ANSA Task Manager, the interaction can be extended to cover the build-up of a ready-to-run input solver file.

It is expected that the results of the collaboration between SIEMENS PLM and BETA CAE Systems S.A. in the field of Teamcenter – ANSA interaction will serve as an out-of-the-box tool to the CAE engineer, as it combines the capabilities of these well established applications in a simple and straightforward manner.