

## Session H2.6

### DEFINITION AND PARAMETERIZATION OF A TASK MANAGER PROCESS WORKFLOW, APPLIED ON THE GENERATION OF AN ABAQUS LOADCASE

**Stelios Seitanis\***, Michalis Giannakidis  
BETA CAE Systems S. A., Greece

KEYWORDS - Template driven process, parameterization, automation, repeatability, ABAQUS

ABSTRACT - The current trend of template driven CAE analyses imposes the need to define and parameterize flexible and reusable model build-up processes. Within this concept, this presentation will focus on the actions that a CAE analyst should take to achieve this goal.

For any given task of relatively high complexity, the engineer should plan the skeleton of the automated process and continue on to its implementation. Typical aspects in this respect are the recognition of the loadcase being investigated, the respective model and analysis specific data and the organization of all these in a 'data pool'. Regarding the actual implementation, individual task components need to be defined and correlated to each other, to handle model inter-dependencies and allow easy modifications.

This work exploits existing ANSA Task Manager functionality, to demonstrate the generation of a template driven process for an ABAQUS/Standard durability analysis. ANSA, along side ANSA Data Management and Task Manager, promote parameterization and safeguard model quality while keeping the complete process simple and versatile.

TECHNICAL PAPER -

#### 1. INTRODUCTION

The usefulness of a managed organization of a project's data and the parametrized build up of an FE analysis loadcase is widely accepted. This paper is an accumulation of all the considerations an analyst needs to take into account in order to create a reusable CAE process workflow, aiming in the creation of a complete FE analysis model. The work described targets in the planning and implementation of the process, alongside with the definition and parametrization of all the individual entities that are used in the process itself. The possibility of using the same template or components of it in other projects is also considered.

The durability analysis of a vehicle rear Lift Gate is taken as a test case. The tools used to automate the analysis process are the *ANSA Data Manager* and the *ANSA Task Manager*<sup>1</sup>.

---

<sup>1</sup> *ANSA Data Manager* and *ANSA Task Manager* are integrated parts of the ANSA pre-processor. They are commonly referred to as *ANSA DM* and *ANSA TM* respectively.

## 2. PROCESS REQUIREMENTS

The model to be produced from this work is a Rear Gate durability Analysis model with special interest in the areas of i) the modeling of the hinge connecting the Lift Gate to the Car Frame and ii) variations of loading conditions. This model build-up should be based on a *template workflow* that will promote the parametrization and reusability of the whole model and its individual components.

The actual design and model variations this process needs to consider are:

1. variations of the hinge (both on geometry level and modeling representations),
2. study of different Lift Gate loading scenarios and
3. study of these variations at different Lift Gate positions

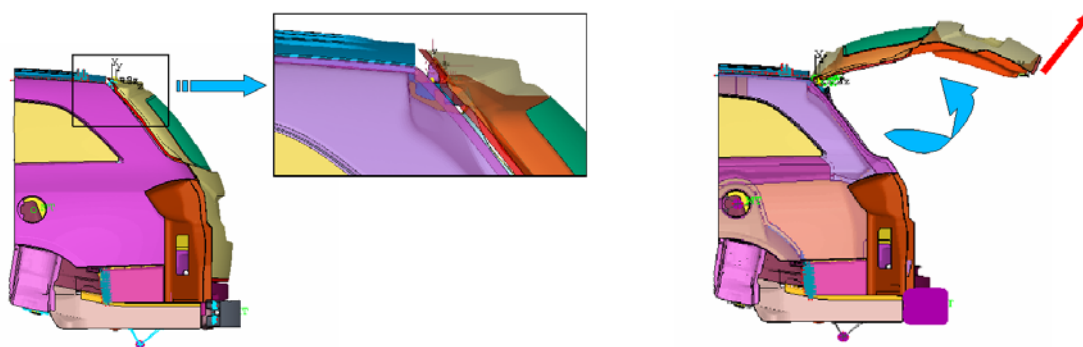


Illustration 1.: Area of interest and position variations of the Lift Gate durability model.

In order to allow easy adaptations to these requirements (Illustration 1), special considerations need to be into account for the general setup and organization of the overall process. These include:

1. Build the Durability model, using a DM configured model
2. Isolate areas of interest for the specific loadcase
3. Position the Lift Gate (open it at a specific angles)
4. Define appropriate connectors, trim items, boundary conditions and loads
5. Parameterize definitions to allow easy adaptations to:
  - (a) geometry changes
  - (b) different vehicle models

## 3. BASIC PROCESS WORKFLOW WETUP

The durability specific model that is considered in this work is based upon the infrastructure of an already existing and fully configured *ANSA DM/Task model*. This implies that an existing data pool of the model's geometry data is already available. This data pool hosts (among others) the '*common representations*' of all the parts of the vehicle.

Moreover, the 'Common Model' section of the Task Manager is also setup and functional for the specific project. This Task template includes the model's geometry as a hierarchy of parts having the common model representations, connections for the total assembly and abstract definitions of *Connectors and Model Trimming*, all suitable for the Common Model description.

The existence of the ANSA DM data pool and the availability of the TASK Manager template functionalities are important parts of the loadcase build-up process. The ANSA DM functionality binds our workflow to the changes made in the geometry level allowing us to adopt them with minimal effort, handle the data that we produce and also have these shared and reused by other engineers. ANSA TASK Manager functionality completes the aforementioned and gives us the possibility to describe our complete process as a template,

allowing an easy overview of the process and the interdependencies of the items that it consists of.

With the usage of the Connectors, Boundary Conditions and Output Requests definitions available in ANSA alongside the ANSA scripting functionality we are able to proceed to the generation of a parametric ABAQUS Durability Analysis Template.

#### 4. PLANNING OF THE WORKFLOW SKELETON (TEMPLATE CREATION)

As any complete TASK Manager Template, our durability template consists of three top level sections: i) the Common Model (already available in our case), ii) the ABAQUS Common Model, hereon named 'Lift Gate Common Model' and iii) the respective ABAQUS loadcase, hereon the 'Lift Gate Load Case'.

As usual, the groups in the common model section are already available and stripped of any solution scenario dependent entities. They need to be changed to suitable representations or realized for the specific load case. In turn, the Lift Gate Common Model serves two purposes. First, it will transform the Common Model into a form suitable for all the ABAQUS analyses that will follow. Secondly it will add the solution dependent entities for all the loadcases that will follow. Finally, the Lift Gate loadcase will add to the model all loadcase dependent entities and will feed the model to the solver.

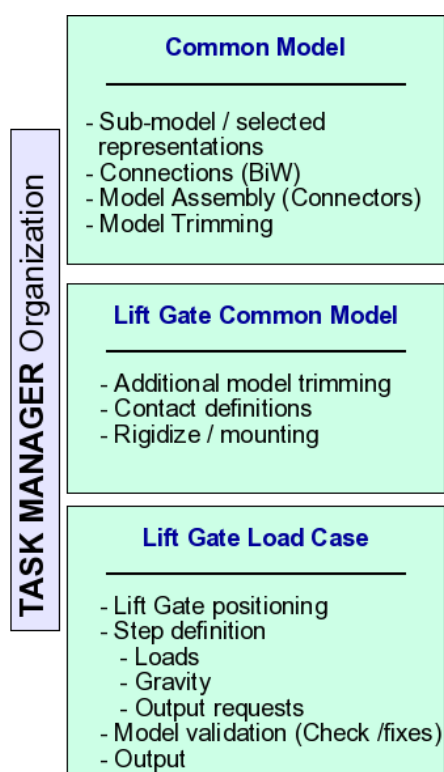


Illustration 2.: Template skeleton of the parametrized ABAQUS durability analysis and its respective sections

## 5. PREPARING THE DURABILITY REPRESENTATIONS

As previously mentioned, the ABAQUS durability loadcase we prepare is based on the Common Model representation of the complete vehicle. This gives us the complete collection of all the components of the model in the Task Manager Tree (Illustration 3). Here, the representations of these components need to be changed to a form suitable for our analysis. We will call this representation the *Durability Representation*. This is done with the use of the 'Change Representation' functionality of ANSA DM. We may find the Durability versions of parts already available in DM, or we may need to go through the process of creating them. In the latter case, we can then publish these in the central Data Pool, thus making them available for use by other engineers.

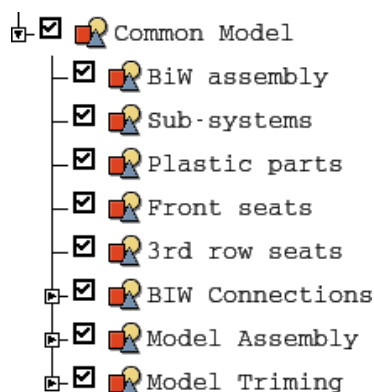


Illustration 3.: Task Manager Common Model section.  
Entities in this section need to have their representation changed to '*Durability*'.

After the parts have their representations changed, the model's geometry serves us no other purpose in the model. For this reason, and also in order to simplify the cut of the vehicle according to the loadcase specifications (see Section:7. *The Lift Gate Common MODEL*), the elements are released from the geometry, and the geometry is deleted.

## 6. ASSEMBLING AND TRIMMING IN THE COMMON MODEL SECTION

The abstract definitions of Connections, Connectors and Body Trimming in the Common Section need to be properly parametrized and also realized as suitable ABAQUS entities. The connectors of the Lift Gate's hinges' that we will review later on in more detail are also found in this section.

## 7. THE LIFT GATE COMMON MODEL

The Lift Gate Common model, is an abstraction of the Durability Common Model. In this section, specific parts have their representations changed to match the durability analysis requirements or modeling needs. This modifications includes, for example, the removal of the suspension system by changing its representation into 'Don't Use'. This process relieves the model from non relevant parts.

Moreover at this part of the template, the parameter of the cut of the BiW at a position along the vehicle axis (defined in the analysis specs) is applied. After this, the model is ready to be mounted (Illustration 9).

## 8. THE LIFT GATE LOADCASE

In conjunction with the ABAQUS specific Common Model, the Load Case Group will position the Lift Gate, apply proper loads and define the desired output requests. Finally the model will be validated and checked against errors, in the scope of the current analysis.

## 9. MODELING OF HINGES – CONNECTOR PARAMETERIZATION

In all the rear lift gate durability projects for which our template is being parameterized, frequent and extensive modifications of the hinge (either geometric or FE) are expected. This calls for special planning on the design stage of the template in order to allow modifications on the modeling of the hinges in a way that is efficient for the engineer.

To make the preparation of the hinges easy, each hinge is modeled separately. This includes all of its geometry and its *internal connectors*. Each hinge model is then saved in DM as a new representation for the *Hinge Group*.

The hinges connectivity to the BiW, is achieved with the *external connectors*. These are saved in the master model and are properly parameterized so as to work with different hinge representations. This set-up allows an automatic realization of the hinge's connectivity to the structure each time a new version of the hinge becomes available (Illustration 4).

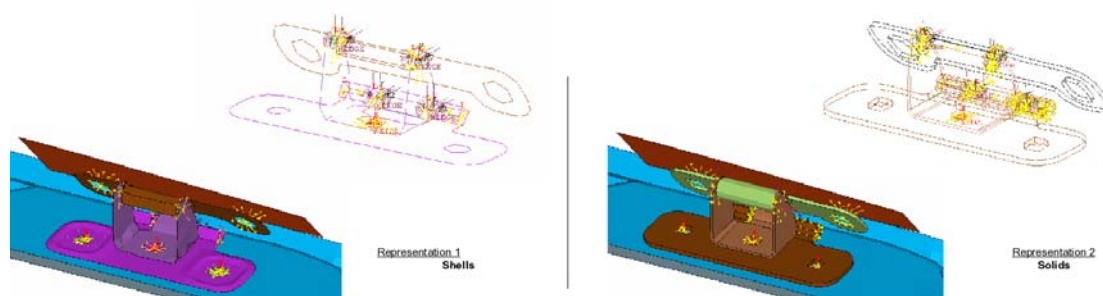


Illustration 4.: Different representations of a hinge (shells and solids), with internal and external connectors realized

## 10. CONNECTORS' DEFINITION AND PARAMETERIZATION

The requirement to automatically connect with each other different parts of the hinge and also the hinge to the car body through kinematic joints, is achieved with the use of *ANSA Connector* entities. These entities allow the definition of their main part (the body) to reside in the DM as a library item. Moreover, they have the capability to attach on the parts they connect through interfaces based on the results of parametric searches. For more details on defining a Connector entity, refer to the respective section of the ANSA User's Guide (1).

The wise selection of the connectors' parameters is important since all subsequent realization will be based on these values. These parameters need to be chosen in a way that modifications to the geometry of the hinge will not invalidate them.

In order to achieve this, the definition of the connectivity for the connected parts needs to be chosen properly. It can be either the *Module Ids of Parts* or the *Property Ids*, depending on which attribute is expected to remain the same when the hinge is changed. In our case the Module Id was chosen, because in case the hinge was modeled with solids, then the Property Ids were expected to change.

Also, when defining the searches for the connectors interfaces, the more specific search patterns should be preferred (when possible) instead of general ones. This means that search for 'NamedEntities' on a given 'Connectivity' should be preferable in most cases. Similarly, searches for circular features (applicable both for shells and solids) should be preferred over searches for Holes (applicable only for shells) or Nodes in a given radius. In cases where Connectors are attached to each other forming chains, the names of the attachment points (e.g. attach\_node1, attach\_node2) should be used in the search pattern of the next connector.

Finally, if any of the connector's parameters depend on its actual position in space, then the user will need to move it if the corresponding connectivity parts are also moved.

Connectors, after being defined in the Task Template, are realized automatically. Moreover they get updated of model changes that affect them and potentially invalidate them. For this reason they have a status flag to indicate if they are built against the latest model changes (Illustration 5).

Id	Name	search1	search2	interface1	interface2	status
1	Hinge_Lift_Gate_A_Axial_Connector	CircularFeature	Node	Rbe2	Rbe2	ok
2	Hinge_Lift_Gate_A_B5	NamedEntities	NamedEntities	None	None	ok
3	Hinge_Lift_Gate_A_B4	NamedEntities	Node	None	Rbe2	ok
4	Hinge_Lift_Gate_A_B3	Node	Node	Rbe2	Rbe2	ok

Illustration 5.: List of connectors used as internal in the hinge group. Their definition parameters and realization status are shown in the list.

## 11. SPECIALIZED CONNECTORS

As a complement to the previous connector definitions, the representation and the interface of each connector can be customized through user scripts. A script that creates the connector representation can be invoked and passed on the results of the search patterns. Moreover, a second script can control the creation of the interface.

In our model, we used a specialized realization of the connectors to create contacts among the hinge parts and the connecting frames on the car (Illustration 6).

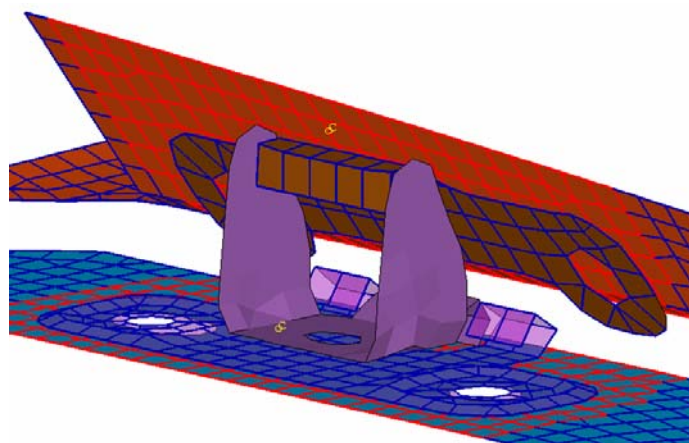


Illustration 6.: Contact Pairs created through connector entities. Search is performed by the Shell\_SolidFacet pattern

Even in the case of specialized connectors, ANSA Task manager can track the connector's status, delete and re-apply it when needed.

## 12. LIFT GATE COMMON MODEL CREATION

Model preparations similar to those of the Common Model are required also in the Lift Gate (analysis specific) common model. In this section all the analysis specific modifications that are needed for the model setup are gathered. In principal these are similar to those in the common section.

The most important part in this section of the template is the cut of the complete vehicle by a plane along its X axis (Illustration 7 and Illustration 8).

## 13. LOAD CASE SPECIFIC MODEL TRIMMING AND MOUNTING

The cutting position of the model, is given in the analysis specifications. For simplicity reasons, this parameter needs to correspond to a single parameter and action in our template. This will ensure that the model's geometry is modified in a single step and that the proper mountings are defined at the same time.

The cut to the vehicle is performed with the use of an ANSA User Script embedded in the template. This script, given the cut position along the X axis from the specifications as a parameter, removes all model entities that lay in front of the cutting plane. Elements with free nodes after the cut, are attached to an appropriate rigid body. A boundary condition is then defined on the master node of the rigid body, so as to mount the model (Illustration 9).

The script's actions that compose this task are:

1. find entities behind the cutting plane,
2. replace these with an appropriate rigid entity (in our case MPC, TYPE=LINK) and
3. apply the proper mounting/boundary conditions

The actual internal workings of the script are similar to those performed with the Rigidize function.

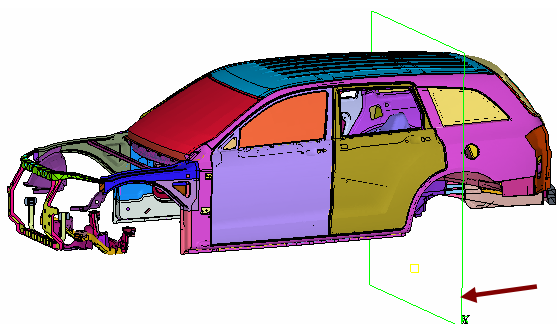


Illustration 7.: BiW and plane indicating the cutting position along the X axis.

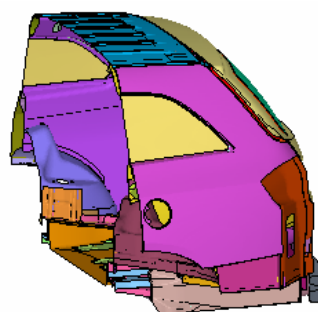


Illustration 8.: BiW after being trimmed at the desired position.

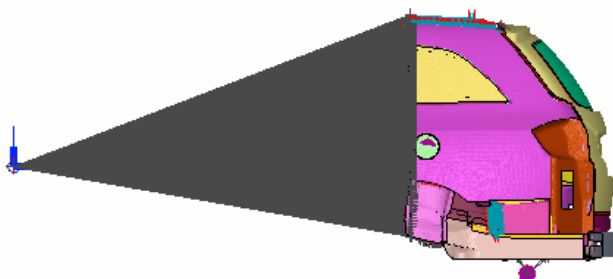


Illustration 9.: Vehicle model, trimmed by the cutting plane and mounted.

## 14. LIFT GATE LOAD CASE CREATION

The third and final part of the Durability template needs to address the issues of positioning the Lift Gate, applying loads to the structure and creating the required Output Requests. All these actions need to be parametric in definition and application in order to allow the easy creation and modification of the loadcase.

## 15. LIFT GATE POSITIONING

The Lift Gate needs to be studied at different positions. We handle each of these positions as a parameter to our template workflow. The Lift Gate is positioned and all the related definitions are automatically modified in order to match the new geometry. This behavior is achieved because of the special care that has been taken to define all related connector entities in a parametric way (Illustration 10).

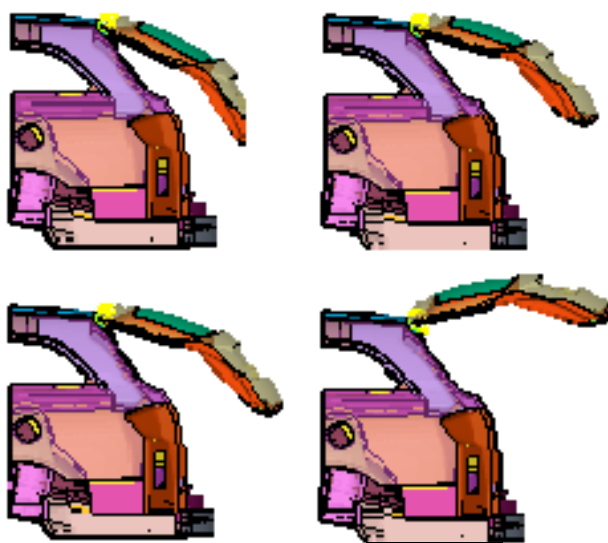


Illustration 10.: Rear Lift Gate at different opening positions

The Gate positioning is done through an *ANSA User Script*. This script is parameterized against the opening angle. It creates a transformation matrix which is applied to the components of the Lift Gate.

The geometrical transformation of the Lift Gate subassembly is simple and requires only the opening angle as a parameter. The axis of rotation is fixed and aligned to the global Y. The components that will be transformed are best defined as a collection of the properties of the Gate. This allows the positioning to succeed even when the model's geometry is modified.

The actual positioning is done through a \*NMAP keyword.



## 16. STEP DEFINITION

The Step definition section of our template needs to consist of two major parts: the application of the loads, and the creation of the Output Requests. These are both predetermined and can be given a parametric definition to allow them to be valid for any model variation our workflow can handle.

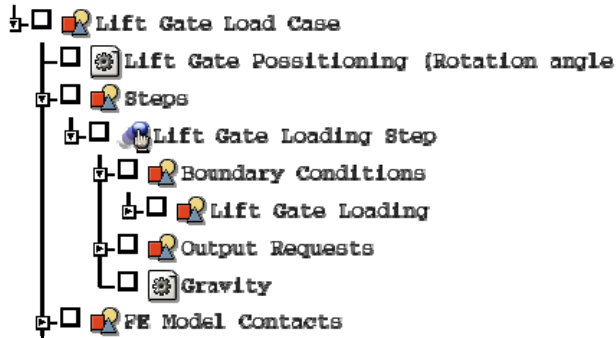


Illustration 11.: Outline of the Lift Gate load case in our Task Manager template

## 17. LOAD DEFINITION

The loading of the Lift Gate is in itself a parameterized definition combining a) an independent library item (Illustration 12) and b) its application method on the model.

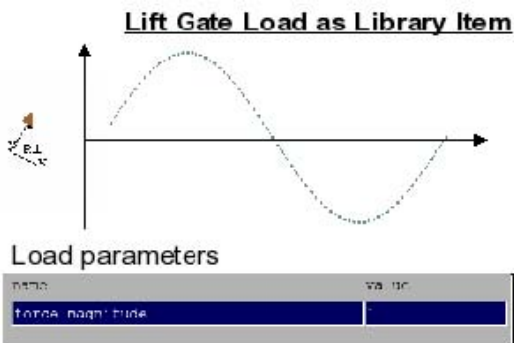


Illustration 12.: Durability analysis load, stored in ANSA DM

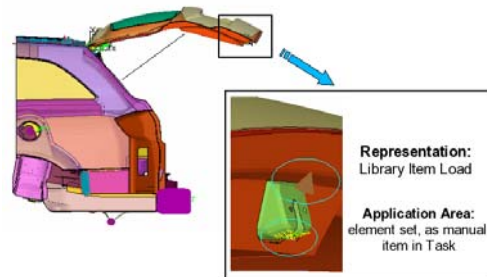


Illustration 13.: Application of the library load on the positioned model.

The loading is saved as a library item in the ANSA DM pool. The load definition is parametrized in the following ways:

1. its magnitude is a model parameter. (given as an A\_PARAMETER definition, named 'force\_magnitude' – through F3 in the entity's edit card)
2. the load is defined on global axis X at position  $[0,0,0]$

The load application is performed through the use of a '*GEB Boundary Condition*' entity. This allows the possibility to predefine and automatically detect the application area. Also it allows the proper orientation of the load with respect to the position of the Lift Gate. Finally, it utilizes the parametric definition of the library load by modifying its magnitude as needed. The load application is parametric in terms of:

1. Its direction, given from the '*orientation coordinate*' of the GEB entity. In turn, this coordinate is defined with nodes on the Lift Gate, so that it follows its rotation when it is positioned.
2. Its magnitude. The load's value is defined in the GEB entity (through A\_PARAMETER).
3. Its attachment position. The load is attached on a predefined area on the structure (an existing set) near the lock, with a rigid element as an interface.

## 18. DEFINITION OF OUTPUT REQUESTS

In the analysis template we are preparing, areas of interest where results need to be studied during post-processing, are already known (Illustration 14). Moreover, the type of required results are also known as well as the frequency in which these should be written to the solution output database (in our case the ODB).

With this information available, suitable output requests can be applied through the use of generic entities, lying at the Step section of the template.

This approach of defining Output Requests with Generic Entities leads to the automatic creation of the required node and element sets of the \*NODE OUTPUT and \*ELEMENT OUTPUT keywords (Illustration 15). The respective entities are detected through parameterized searches and assigned to the Output Requests. The usual considerations on the parameterization of Generic entities such as Connectors, apply here as well.

In our example, the nodes of the pin and the elements of the hinge are automatically assigned to node-output and element-output requests respectively. In particular, nodes are searched by name and elements are searched by connectivity.



Illustration 14.: Detail of the hinge. Area of interest where output request are defined.

Output requests:		
OPTION	SET ID	SET NAME
*OUTPUT		
*NODE OUTPUT	17936	Hinge LT: Gate Side Pin
*OUTPUT		
*ELEMENT OUTPUT	17939	Hinge LT: Body Side Elem

Illustration 15.: List of output requests for the durability \*STEP

## 19. VALIDATION OF THE MODEL AND MODEL OUTPUT

The template process that is proposed in this paper ensures that a complete model will be produced and no modeling actions will be missed or left unattended.

Moreover, the template can be expanded to include and automatically perform a wide collection of checks available in ANSA. These checks will be run just before the process workflow completes.

With the completion of the checks, the template can output the complete model. As with everything else, the process can have predefined settings of all the output parameters.

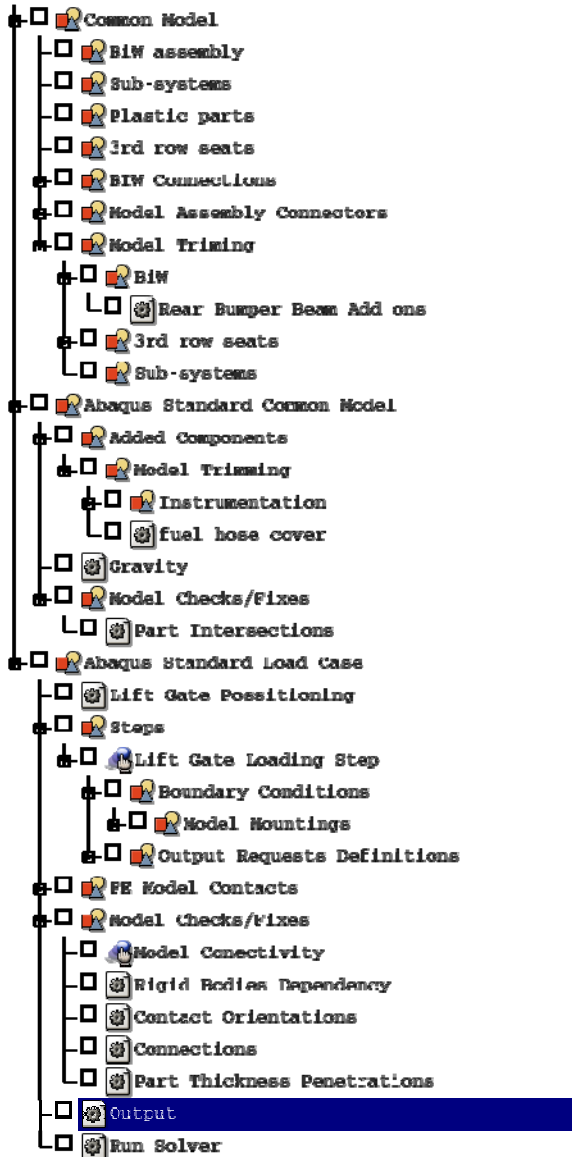


Illustration 16.: Complete TASK Manager template of the durability process workflow.

## 20. CONCLUSIONS

The creation of a template based process requires investigation and planning. Many of the every day practices and data handling rules of the host CAE environment have a direct affect on it. Moreover, the specific parameters and variations that the given analysis scenario wants to address need to be thoroughly considered.

All the existing model build-up techniques and the projects new requirements need to be incorporated in the newly designed template. Usage on ANSA TM and ANSA DM, as well as the parametrization guidelines described in this paper, help in making the complete process automatic, reusable and extensible (Illustration 16).

The effort spent on creating such a template process pays off. Reasons that make this true are:

1. Changes in analysis parameters are easily applied, while modifications of crucial areas / components are seamlessly imported.
2. The process becomes repeatable and robust: Actions needed to build a model are followed in sequence, considering their inter-dependencies.
3. The template process aims to reduce the overall CAE turnaround time.
4. Association with ANSA DM assists data collection and organization and promotes the use of library items.
5. Model quality becomes inherent in the process and does not depend on user experience/expertise.

## REFERENCES

- (1) ANSA v12.1.2 User's Guide, BETA CAE Systems S.A., 2007
- (2) M. Giannakidis, "Outline and features of a multi-disciplinary Finite Element pre-processing system, capable of generating complete and reusable models for the field of mechanical engineering analysis", Engineering Doctorate Thesis, Aristoteles University of Thessaloniki, 2007