AUTOMATIC GENERATION OF HIGH-QUALITY CAE MODEL USING ANSA

[1]Masahiko Yanagisawa, [2]Maiko Kato*
[1] Hino Motors, Ltd., Japan, [2] BETA CAE Systems Japan Inc., Japan

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ABSTRACT –
With improvements in analysis precision and computer performance, complex CAE models are required in order to faithfully reproduce an actual vehicle. However, it is difficult to meet the demand for stable quality on a limited development schedule if a conventional modelling approach is used. Therefore, to generate high-quality CAE models in a short time, a new automation tool has been developed using ANSA.

Automation has been applied to the modelling steps: input parameters, meshing, connection creation and model check, for parts of cab sheet metal and chassis frame. It enables users to generate FE models for Durability, NVH and Crash analysis. Connections, which had previously been particularly difficult, are now created much more efficiently by reading connectivity information automatically in the tool.

Additionally, there are various criteria regarding mesh and connection which directly affect the analysis results and therefore must be satisfied. Beginners typically spend many hours to meet these requirements, while experts can meet them in less time due to their specialized knowledge of the modelling process. Therefore, we quantified such experts' know-how and standardized it as criteria in the tool so that anyone can generate high-quality FE models.

Thus, applying the automation tool to the development process greatly reduced the time needed to create CAE models with stable quality. Expansion of this automation to other components and efficiency improvements in input design parameters are planned to be addressed in the future.

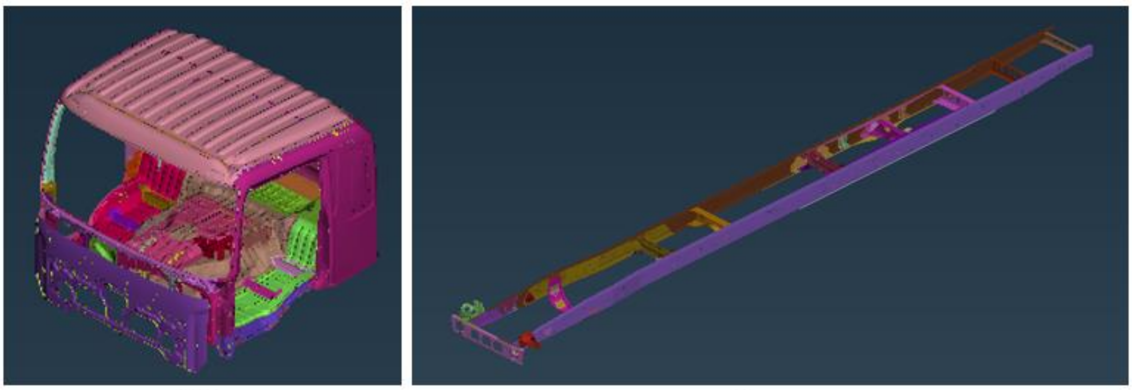
TECHNICAL PAPER -

1. INTRODUCTION

With improvements in analysis precision and computer performance, complex CAE models are required in order to faithfully reproduce an actual vehicle. However, the conventional modelling approach in Hino was mainly manual. They had to take into account several analysis disciplines, but also the different rules for each analysis, and because the modelling methods varied between Cab and Frame models this led to engineers spending an enormous amount of man-hours to create CAE truck models. Additionally, there was a concern that the model quality may differ depending on the engineer's skill, thus it was difficult to meet the demand for stable quality on a tight development schedule.

Therefore, BETA CAE Systems Japan has developed a new modelling automation tool using ANSA, for the purpose of generating high-quality CAE models in a short time. We automated and standardized the modelling steps: input parameters, meshing, connection creation and model check, focusing on parts of cab sheet metal and chassis frame of Durability, NVH and Crash disciplines.

This paper describes, how the automation for creating truck CAE models is achieved using ANSA. Section 2 explains the overview of the tool and how we achieved automation. Section 3 presents the results and advantages gained by applying the automation tool to development in Hino. Finally, conclusions are presented in Section 4.



Cab Frame

Figure 1 – Truck cab and frame

2. DESCRIPTION OF THE AUTOMATION TOOL

<u>Overview</u>

There are some modelling procedures which do not depend on the analysis discipline before mesh creation: CAD translation, input engineering information (e.g. properties and materials), extraction of middle surfaces, connectivity definition and geometry checks etc. In this tool, such procedures which are independent of analysis discipline have been integrated based on the Common Model Concept, which is recommended by BETA CAE Systems. In other words, this tool lets users carry out the procedures before meshing only once, then distribute this model to different discipline analyses as the Common Model before proceeding to steps of meshing and assembly which vary based on discipline. Thus, the modelling procedures in Hino have been improved.

Additionally, in this project, modelling procedures have been standardized using the functionality of ANSA Task Manager, by subdividing into appropriate procedures. Tasks consist of five types of function groups: creating common model, meshing, mesh checks, assembly and model checks. Each function group has various task items, which are associated with Python user scripts, to enable users to perform modelling procedures in order.

1. Creating Common Model Task
   CAD translation, input of engineering information (e.g. properties and materials), extraction of middle surfaces, connectivity definition are carried out. Geometry, penetration and connections are checked. Users fix detected errors. Parts are saved in DM and common model database is saved.
2. Meshing Task
   Common model database is read and batch mesh is executed.
3. Mesh Checks Task
   Mesh quality is checked. Users fix quality violating elements. Parts are saved in DM as meshed representation.
4. Assembly Task
   Connection Templates are merged and applied. Connection elements are checked. Users fix detected errors.
5. Model Checks Task
   Final checks of model regarding mesh quality and connections etc. are performed. Users fix detected errors. Finally, a solver file is output.

The Creating Common Model Task is unique as it is used for all the disciplines in common. The other tasks: Meshing Task, Mesh Checks Task, Assembly Task and Model Checks Task, are designed for each discipline as required. In addition, the analysis requirements for truck CAE models vary with component (Cab or Frame) and mesh size even for the same discipline. Therefore, all tasks except for the Creating Common Model Task are prepared taking into account each their own respective requirements (i.e. discipline x component x mesh size). Users can use a GUI window to execute these tasks in a user-friendly manner. When users select a requirement of discipline, component, mesh size etc., the appropriate tasks for the selected requirement are read automatically so that users can execute the necessary task items in a straightforward manner.

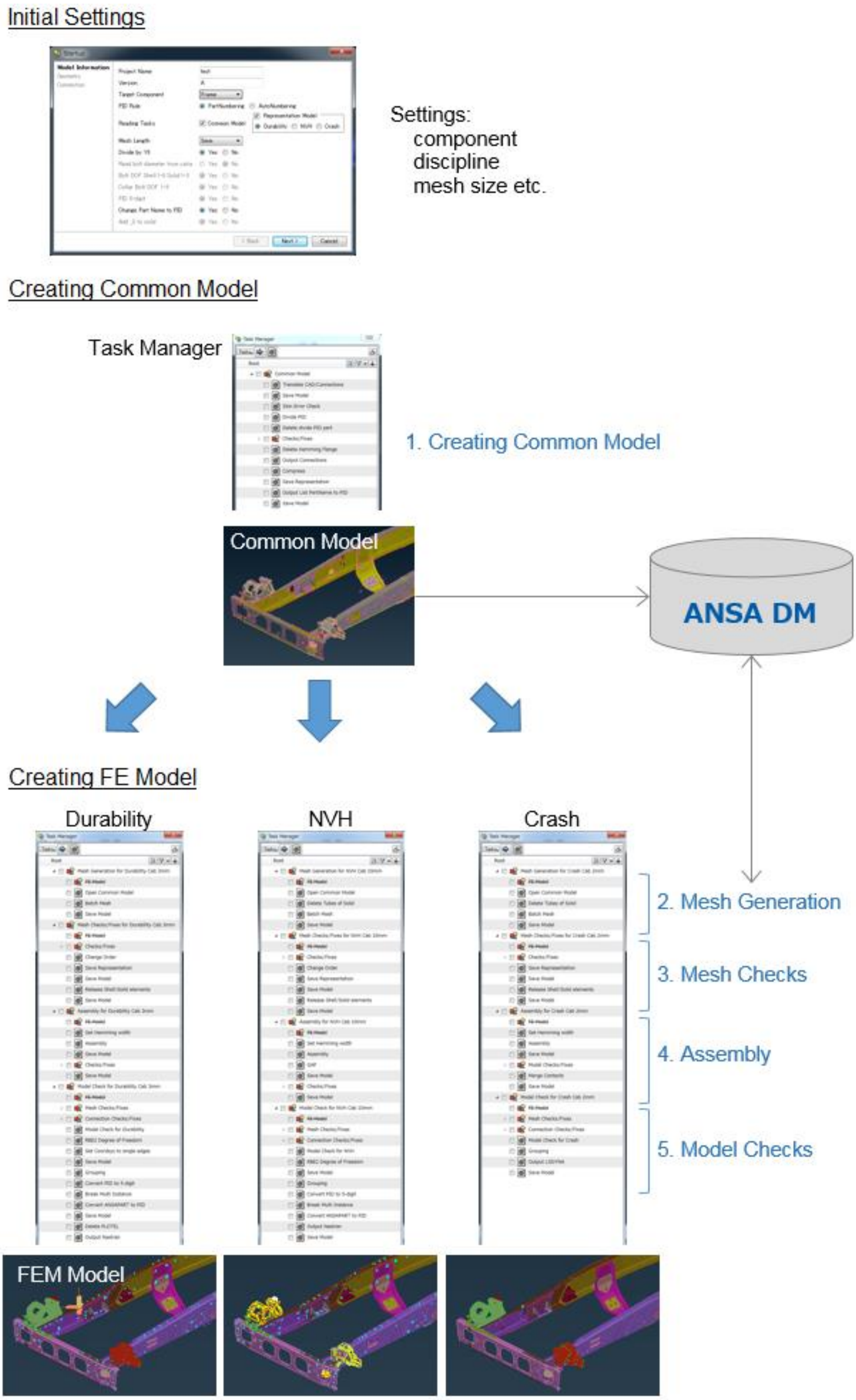


Figure 2 – Modelling workflow using Task Manager

These tasks include various task items and associated user scripts which automate modelling operation and improve the efficiency of each procedure. Additionally, users can efficiently generate models with stable quality as they are guided by task items which include various check functions in addition to automated functions.

Automated assembly

In the assembly process, Hino previously input connectivity information manually and specified modelling requirements (i.e. mesh and constraint) of connections by confirming them each time. For bolt connections, it was particularly difficult to specify the connectivity information for more than several hundred bolt connections in a model, because bolts have many types of specifications (e.g. bolt diameter, flange diameter). To improve this, the procedures for setting of connectivity information and applying connections have been automated in this tool.

At first, users prepare CAD files containing points and curves which describe connectivity information (i.e. connection type and connectivity parts). This tool uses the connectivity information acquired from these files to automatically generate the necessary connection entities in ANSA. Additionally, for bolt connections it automatically creates connection entities and detects their connectivity parts from the bolt geometry included in the CAD files. This automated input for bolt connections is implemented by matching the attributes being read from bolt geometry in CAD files with the information included in a bolt list, which is a text file including bolt specification information (i.e. part number, bolt diameter and flange diameter) and mesh parameters.

Furthermore, not only is the connection method different between Durability, NVH and Crash disciplines, but it also varies with conditions such as components and mesh size in truck models within a single discipline. To deal with these various situations, assembly is performed by Connection Templates. We created connection templates that satisfy these various requirements in Hino, so that various types of connections can be generated by applying templates according to the situation selected by users. Additionally, we customized some connection templates using post realization functions, in order to create connections meeting some of Hino’s unique requirements.

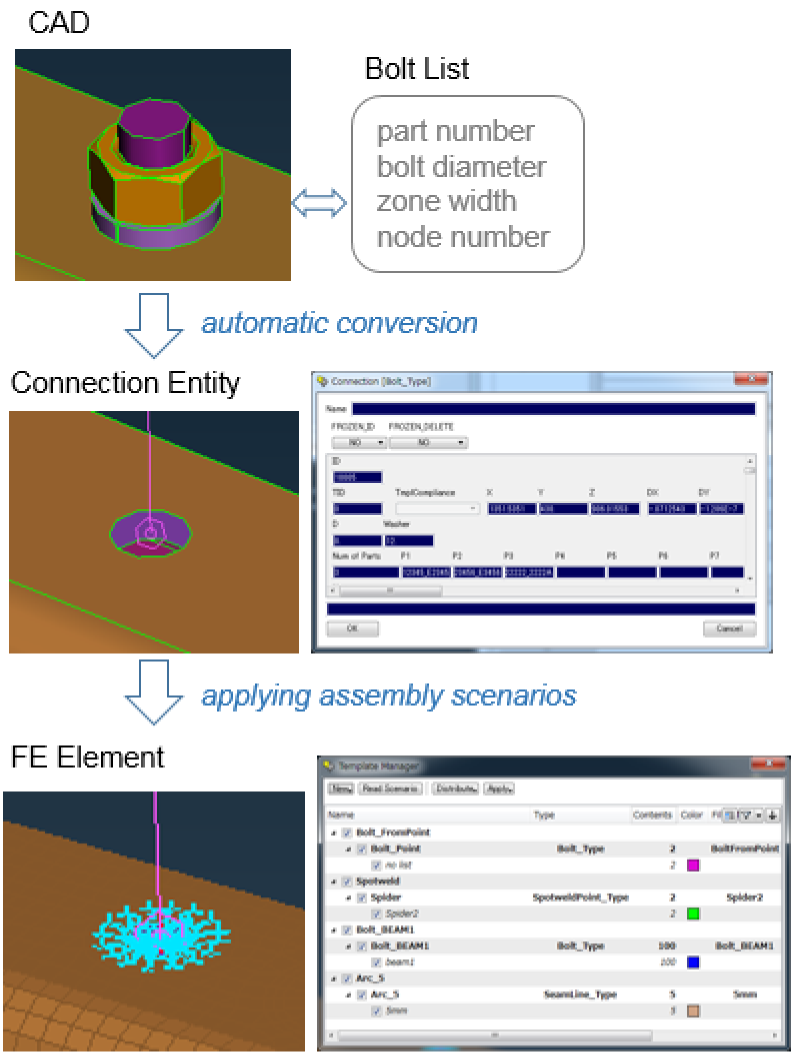


Figure 3 – Workflow of bolt connection using geometry model

Discipline		Durability			NVH				Crash					
Component		Cab		Frame	Cab		Frame		Cab			Frame		
Mesh Size		a	b	c	d	e	f	g	h	i	j	k	l	m
Spot	type1	○		○										
	type2		○		○	○	○	○						
	type3								○	○	○	○		
Bolt	type1	○	○	○	○	○	○	○						
	type2		○		○	○	○	○						
	type3								○	○	○	○	○	
	type4								○	○	○	○	○	○
	type5											○		
	type6			○										
SeamLine	type1	○												
	type2			○										
	type3		○		○	○	○	○						
	type4		○		○	○	○	○						
	type5								○	○	○	○	○	○
	type6	○	○						○	○	○	○	○	○
Hemming	type1	○	○		○	○								
	type2		○		○	○								
	type3								○	○	○			
Mastic	type1	○	○		○	○								
	type2		○		○	○								

Figure 4 – Main connection types

Standardization of model quality and check

There are various criteria regarding mesh and connections which directly affect the analysis results and therefore must be satisfied. Beginners typically spend many hours to meet these requirements as they are unfamiliar with mesh creation (and the particular requirements), while experts can meet them in less time due to their specialized knowledge of the modelling process. Therefore we quantified such experts' know-how and standardized it as criteria in the tool so that anyone can generate high-quality FE models. The initial quality of models generated by the automation tool has been improved by incorporating these optimized mesh parameters and quality criteria into batch mesh scenarios.

On the other hand, we also standardized the model check processes using the Checks Manager functionality in ANSA. Various types of model check functions are incorporated in this tool as connection templates in Checks Manager. These check functions include not only standard the check functions embedded in ANSA but also customized check functions, which were developed in this project in order to support Hino's own particular specifications.

Thus, anyone can now create a high quality model in a short time due to this quantification of modelling experts' know-how and standardization of the model check processes.

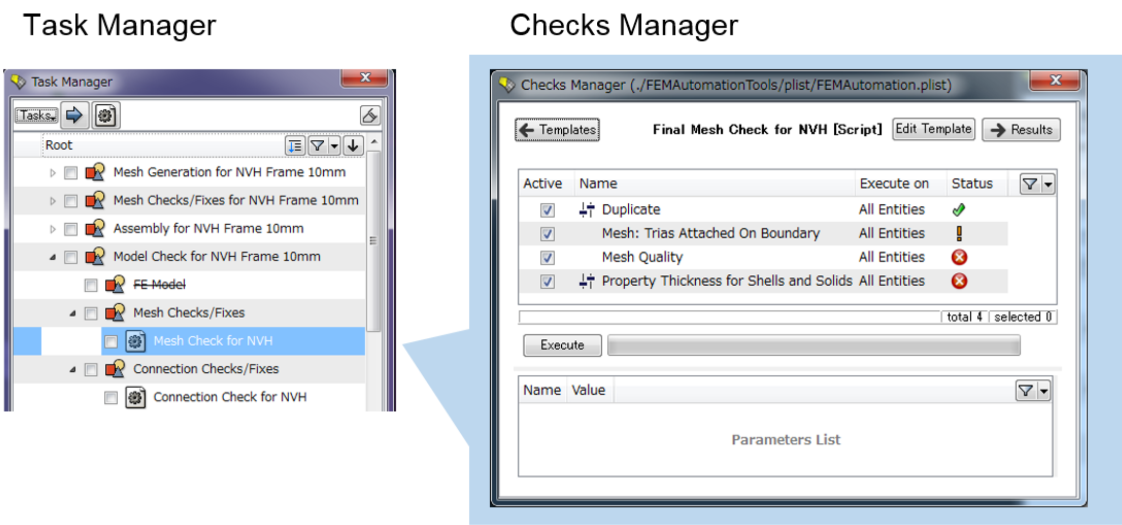


Figure 5 – Standardization of model checks/fixes

3. THE RESULTS OF APPLICATION

As a result of applying the aforementioned automation tool to the development process in Hino, the time needed to create CAE models with stable quality was greatly reduced. However, the time of inputting design parameters was increased because users had to input these parameters to CAD files in order to use the automation input process. If the design department could prepare these parameters in advance, further optimization could be achieved.

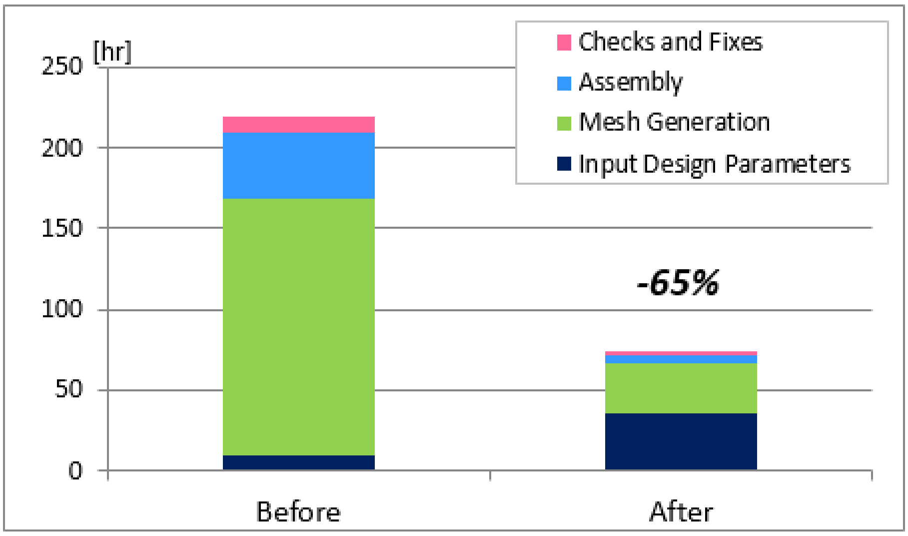


Figure 6 – The effects of modelling automation (Cab model)

Advantages that can be gained by adoption of the automation tool we developed are as follows:

- Standardization of modelling procedures and their rules
  Since users now carry out a series of processes of modelling by navigation of ANSA Task Manager, they can avoid missing any modelling procedures. Even an engineer who does not have much experience with model creation is now able to carry out a standard process within a relatively short time. Additionally, a reduction in calculation variation is expected due to the standardization of mesh parameters and quality criteria.

- Improvement of efficiency and reliability when creating FE models using common model
  The procedures before mesh creation are improved by using Common Models in different CAE departments, which means users now perform the following operations only once: CAD translation, input engineering information (e.g. properties and materials), extraction of middle surfaces, connectivity definition and geometry checks etc. Furthermore, users can now share product information such as part numbers between different analysis disciplines, which has led to the promotion of information sharing and the improvement of the reliability of CAE models. Since parts are saved in ANSA DM with the product information, further efficiency when applying a design change is expected in the future.

- Improvement of efficiency by automation of modelling procedures
  We automated various operations regarding CAD translation, input design parameters, mesh creation, assembly and model checks, which led to users improving efficiency of the whole process of creation of CAE models.

4. CONCLUSIONS

An automation tool using ANSA has been developed for Hino which generates high-quality CAE models with stable quality in a short time. We automated and standardized the modelling steps: input parameters, meshing, connection creation and model check, focusing on parts of cab sheet metal and chassis frame for Durability, NVH and Crash discipline.
Applying the automation tool to the development process in Hino greatly reduced the time needed to create CAE models with stable quality.
Expansion of this automation to other components and efficiency improvements in input design parameters are planned to be addressed in the future.

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