

Development of Modeling System for Data Proto Model

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ABSTRACT

Honda's Data Proto Model (DPM) is a digitally-modeled prototype vehicle generated through the formulation of three-dimensional data for a complete vehicle and the input of the collected data into a computer. This paper discusses the development of two three-dimensional modeling systems for the vehicle body, which forms part of the DPM. One of these systems makes use of global time differences to enable modeling before the issue of design drawings, making an image of the latest body constantly available to designers. The other is a modeling system based on the BOM (Bill of material) established after the issue of design drawings. These systems enable other designers and members of the manufacturing division to refer on a daily basis to the latest form of the body. The DPM also enables constant review of specifications in the initial stages of design. A system was developed to facilitate DPM verification meetings; these bring together specialists to run checks on interference between components, review the design layout, etc., using DPM. As a result, any designer is able to use DPM for verification of the appropriateness of design, and the system is now in use in Honda's design departments.

1. Introduction

Among product developments in the global manufacturing industry, especially in the aeronautical and automotive industries, new product developments began through input of three dimensional data of all parts of a product in the computer from the early nineties, to perform product verification in the engineering design process, manufacturing process and testing process. (Fig. 1)⁽¹⁾⁻⁽¹¹⁾

Boeing was the first to input the three-dimensional data of all the parts of the product into the computer and use the data for development. Data of approximately 250 000 parts of the full-size models were converted to digital data in the development of the B777. Boeing called this Digital Pre-Assembly (DPA). DPA was used to start the simulation of

assembly before the issue of design drawings. Even though the system development cost 500 billion yen, it has reaped huge benefits in terms of (1) reduction in development costs, (2) improvement in initial quality, (3) reduction in development time, and (4) increase in customer satisfaction^{(1),(2)}.

In 1995, for the first time in the field of vehicle development, Chrysler Corporation input the three-dimensional data of a complete car in the computer for the development of LH car. This was called Digital Model Assembly (DMA), and it marked the start of the assembly simulation of vehicles⁽⁴⁾. In recent years, some automotive companies that can develop vehicles without the physical prototype have also emerged^{(10),(11)}.

Honda started development of automobiles using DPM

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from August 1996, but Honda had concerns regarding DPM. Sometimes, the input of three-dimensional data of all bodies could not be completed; therefore, a complete DPM could not be obtained. Moreover, the demands from all design departments, other than the body department, to create the body surface at the day-to-day design layout stage was high. On the other hand, improved CAD modeling was demanded for the CAD vendors^{(12), (13)}, but no CAD package with innovative surface modeling techniques appeared in the market.

These concerns were resolved by developing a modeling process system before issue of design drawings using time differences between two nations and global networks, and by developing a modeling process system after issue of design drawings. The development of a system for DPM verification also enabled the DPM verification meetings to be held without any concerns.

This document introduces the DPM concept, system development for creating the body surface, and system development for DPM verification.

2. DPM Concept

Honda follows the ‘Sangen’ (the three-gen) concept⁽¹⁴⁾. The concept is to grasp facts and information and to develop products enhancing customer satisfaction by touching the actual object (Gen-butsu) on the actual place (Gen-ba) and by observing the actual fact (Gen-jitsu), at the development site. The Sangen concept is also important in the development of vehicles using the computer. Development equivalent to that of actual vehicles is possible using the computer only if actual data (facts, information) of the vehicles can be simulated⁽¹⁵⁾. That is, actual data exists in the real world in the form of data based on tests and data based on experience. Three-dimensional data and the data of results of computer analysis also exist in the computer simulation world. The developers need to grasp the data of both worlds to develop a product. Therefore Honda has taken “Data” as the first word in the expression “Data Proto Model”. (Fig. 2) The prototype based on the data in the computer simulation world was named “Data Proto Model,” corresponding to the “Physical

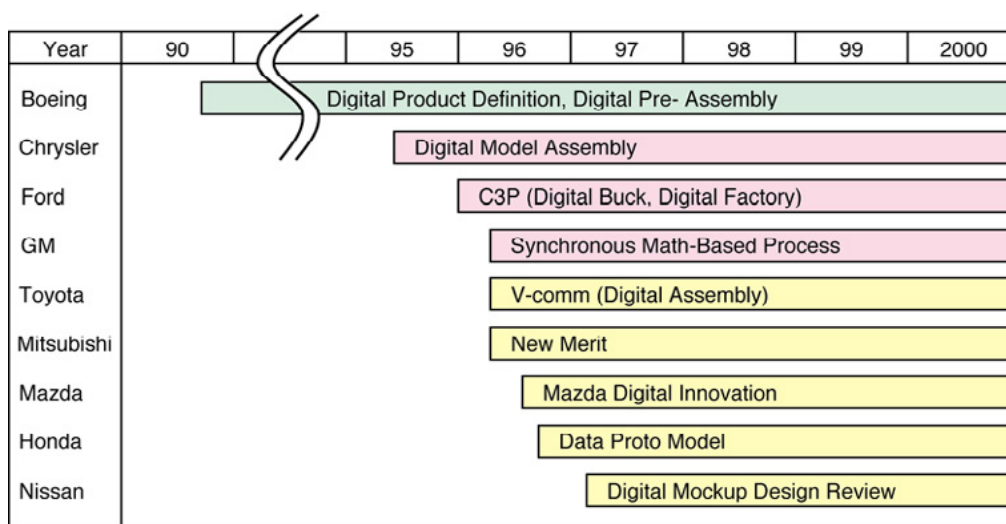


Fig. 1 History of employment of digital modeling in vehicle and airplane development

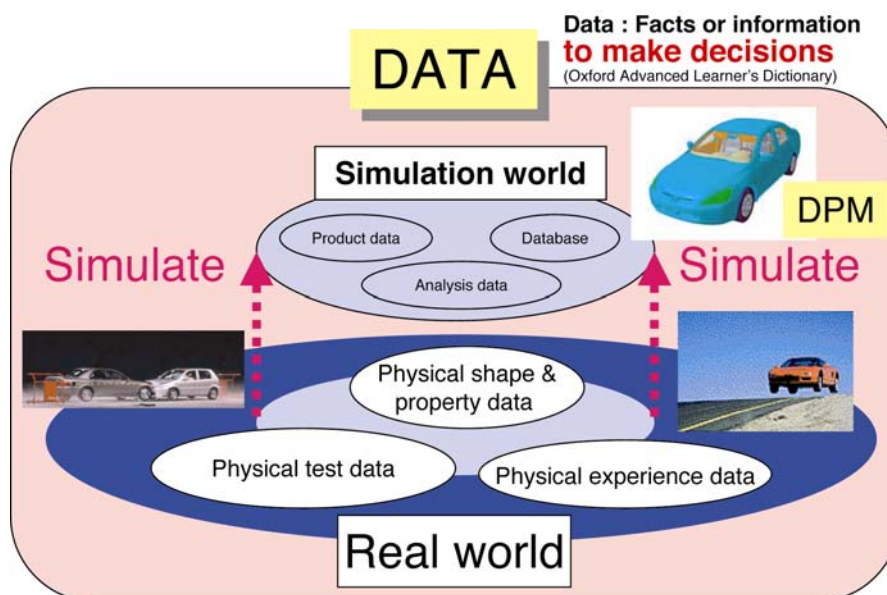


Fig. 2 Image of DPM

Proto Model” for objects. The first vehicle manufactured for tests is called a “Prototype” but it is abbreviated to “Proto” here.

3. Creation of Body Surface

Described here are the issues and their solutions when creating the body surface.

3.1. Issues Faced by Honda in the Conventional Modeling of Body Surface

The following issues have occurred since 1996 in the development of vehicles using DPM.

- (1) As the surface elements are expressed and managed by complex tree structures (Fig. 3) in CAD, the creation and modification of surface data is laborious for the body designers. (Fig. 4)
- (2) Wire frames are mainly used in the body design layout; therefore, it takes time for the manufacturing department and design department other than the body design to understand the body form and to make many sections of body form. As a result, demands for creating the day-to-day body surface at the design layout stage increased constantly.
- (3) During the initial development stage, sometimes the DPM of the complete body could not be used since the three dimensional form data of the complete body was not available although the three dimensional model of the components such as the engine and chassis were available.

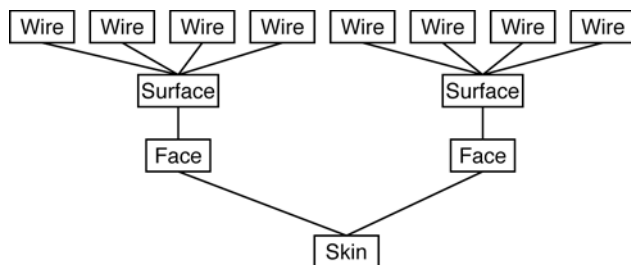


Fig. 3 Structure of elements in CAD

3.2. Modeling Using Time Differences Between Two Nations

The authors considered a modeling system using global network to meet the demands for the constant creation of the body surface (Fig. 5). The modeling support system using the global network was being used since 1997, and thus the foundation for continuous modeling using global time differences was already available. Hence the issues related to constantly creating the body surface could be resolved by using the processes mentioned below (Fig. 6).

- (1) Preparations at the research center
 - Registration of the latest wire frame model by the body designer.
 - Data transmission daily by using the global network to the overseas modeling department.
- (2) Work in the overseas modeling department
 - Laying the surface on the body form by referring to the received wire model.
 - Sending the created body surface to the research center at the decided time on the following day.
- (3) Open work at the research center
 - Registration of the body surface model in the open FILE.
 - Referencing and verification by all departments.

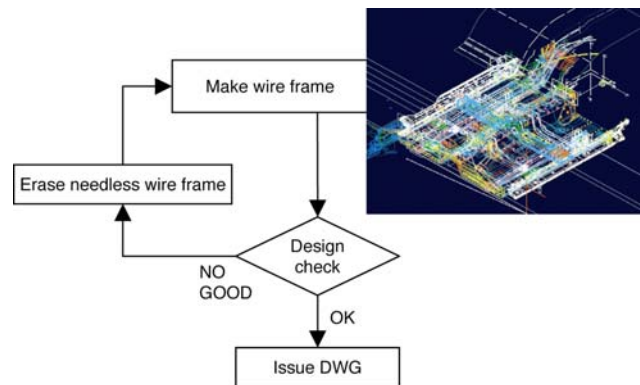


Fig. 4 Former body modeling process

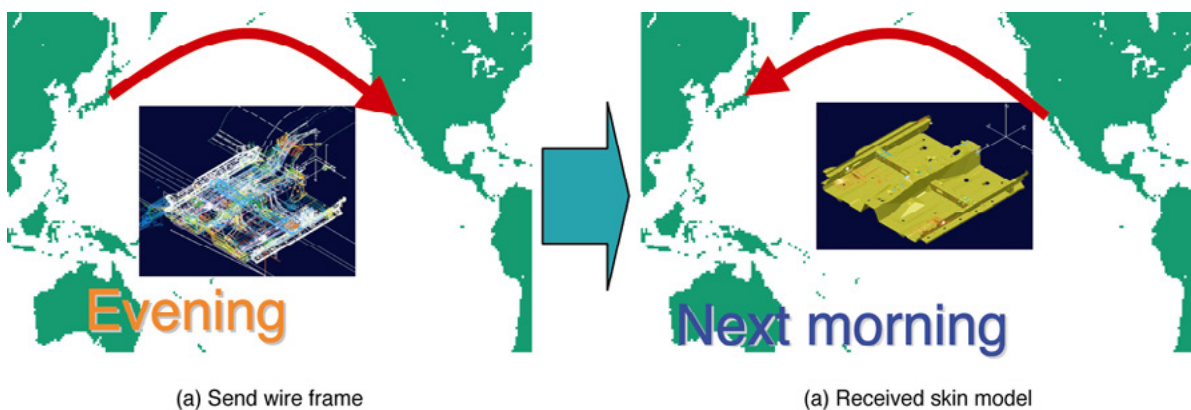


Fig. 5 Modeling of body using time difference

The body surface emerges gradually by repeating these processes.

Since this body surface is conceived and created by persons other than designers, it is set as a tentative surface. It is given a yellow color (signal yellow) and assigned the name Yellow Body (YB) to serve as a warning that it is tentative. Finally, the designers confirm it and determine the body design surface.

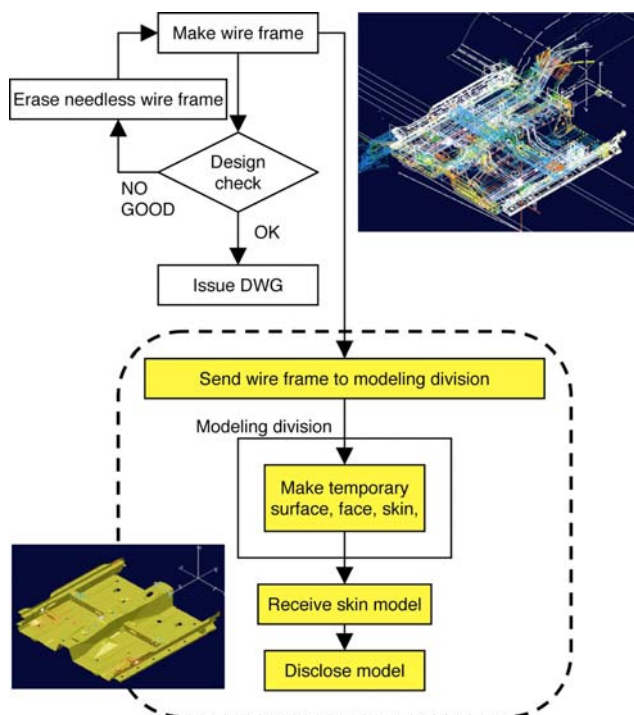


Fig. 6 New modeling of body using time difference

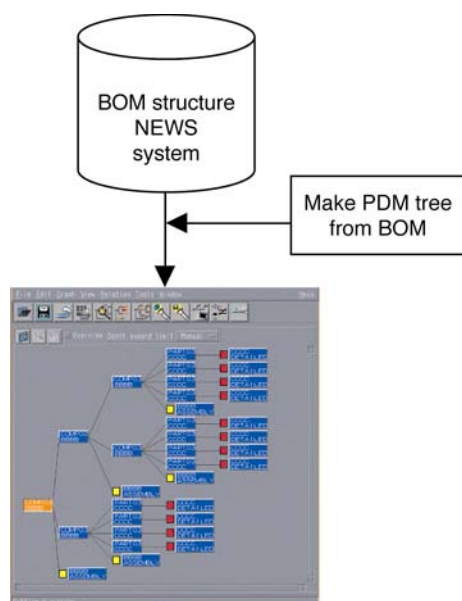


Fig. 7 PDM tree

3.3. Modeling After Issue of Design Drawings

The number of wire frame design drawings issued at the initial stage of development is extremely large, and it is necessary to create an efficient body surface after the formal issue of design drawings. The developed system is described below. This body data is used in DPM verification and analysis, where a more detailed check for interference between parts is required.

3.3.1. Extracting the body parts tree structure data

To efficiently manage the modeling requests and storage of the body data after the issue of design drawings, a function was developed to remove the parts tree structure (tree structure of parts) from the Bill of Materials (BOM) system (Fig. 7) and register it in the Product Data Management (PDM) of the body data.

The process flow is shown below.

- (1) The BOM system outputs the parts tree structure based on information such as a car project name and car variation.
- (2) Delete unnecessary parts tree structure (reference drawing, assembly diagram, and specifications, etc.), and use only the parts tree structure of the design drawings required for the body surface.
- (3) Register the parts tree structure in PDM.
- (4) Automatically link the issued body design drawings to the PDM.

In the data management by body PDM, the relationships between the parts are managed by a car variation information and the date.

This enables a total car variation management, where day-to-day changes can be managed.

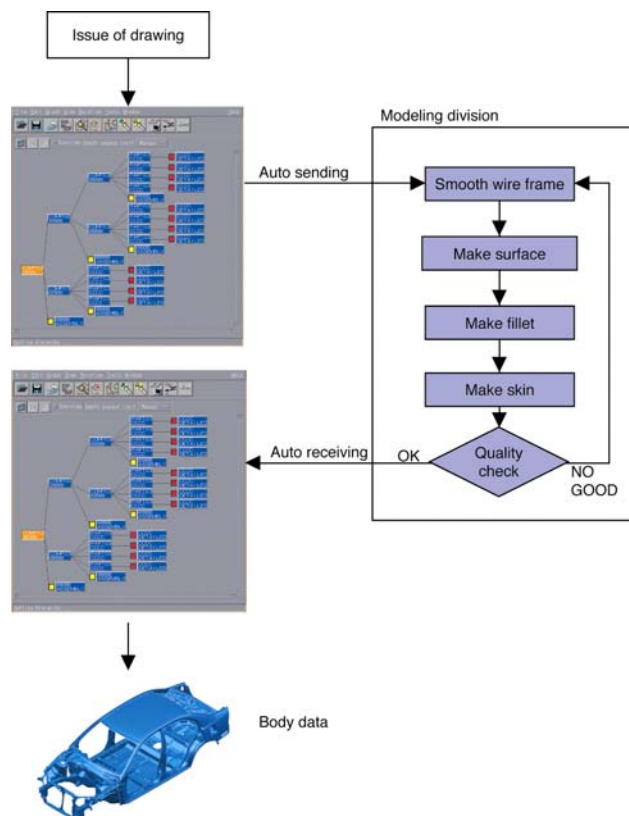


Fig. 8 Body modeling using PDM

3.3.2. Body surface modeling flow after formal issue of design drawings

The body surface modeling flow-using PDM is shown below (Fig. 8).

- (1) The research center simultaneously sends the parts tree structure and design drawings of the body to the modeling department.
- (2) The modeling department creates full data including fillets, and sends that data to the research center.
- (3) The research center registers the received full data in the PDM.

STandard for the Exchange of Product model data (STEP) is used for the exchange of parts tree structures of the body. This body data is created according to the formally issued design drawings. It is colored in blue (signal blue) to signify safety and is called Blue Body.

4. Development of DPM Verification System

For efficient verification using DPM, a system that can verify DPM was created consisting of a line up ranging from DPM room facility with large screens to notebook type Mobile PC (Fig. 9).

(1) DPM room

DPM rooms were provided enabling a large number of people to perform DPM verification simultaneously. The

switching operations are likely to become complicated in a system using multiple screens of the 70 to 110-inch class. Accordingly, the operations were simplified by creating a user-friendly interface that could be understood easily by any designer. The 70-inch class screen system was designed such that it was possible to move the projector and the operations table integrated in the Engineering Work Station (EWS).

(2) Mobile PC

An optimum performance and low cost Mobile PC tool was introduced to view both the physical vehicle and the DPM at the inspection location (next to the actual vehicle) where there is no network.

5. DPM Usage Example

The development of this DPM system enabled various types of verifications and applications to be implemented.

Introduced here is one usage example shown by simple illustrations.

- Extract the necessary parts model from DPM and use the parts in the analysis model (Fig. 10)⁽¹⁶⁾
- Wiring and piping interference check (Fig. 11)
- Body thickness interference check (Fig. 12)
- Engine room regular meeting (Fig. 13)
- Assembly review in the manufacturing division (Fig. 14)
- Application to TV advertisements (Fig. 15)

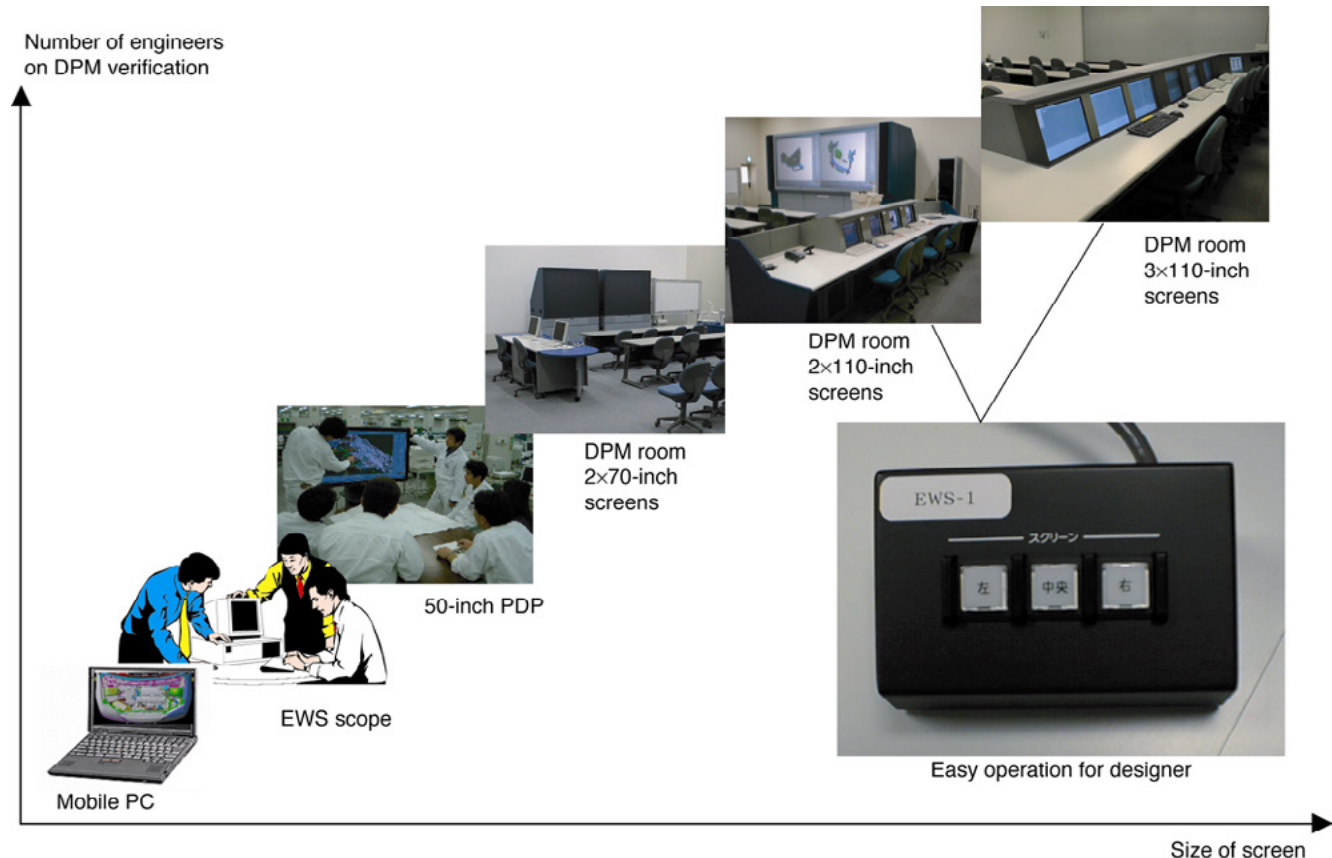


Fig. 9 DPM verification facility

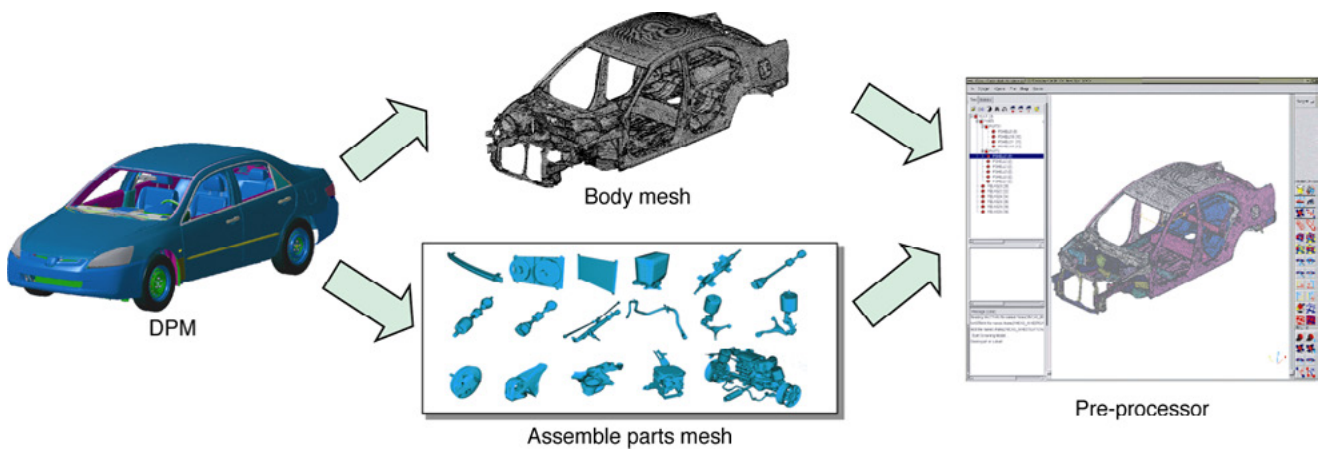


Fig. 10 CAE using DPM

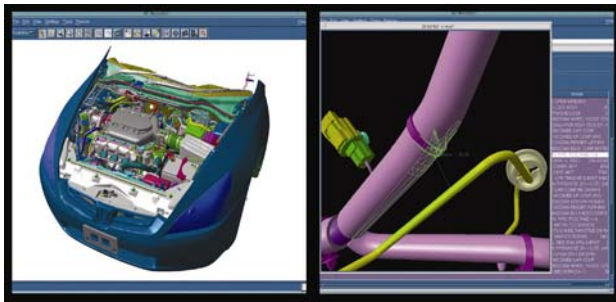


Fig. 11 Verification of wiring using DPM



Fig. 14 Manufacturing division staff using DPM

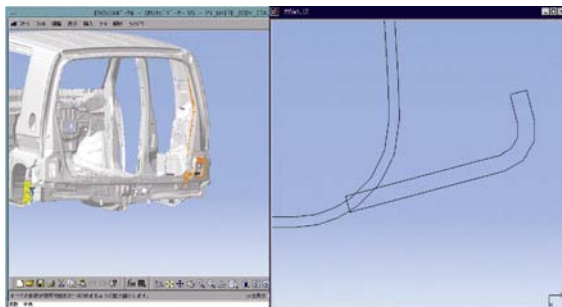


Fig. 12 Thickness interference check using DPM



Fig. 15 TV commercial using DPM

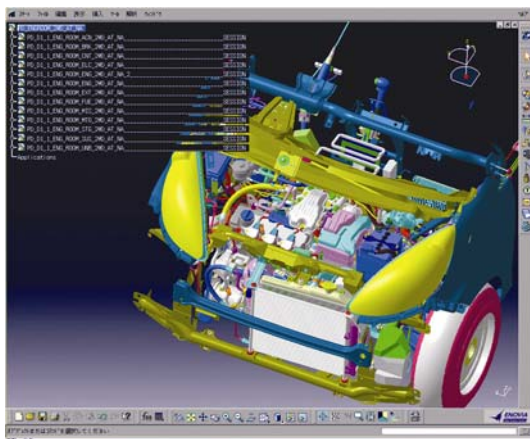


Fig. 13 Engine room layout meeting using DPM

6. Conclusion

- (1) The development of a system for creating a vehicle body surface enabled the following:
 - Viewing of the latest body surface on the computer even at the initial design stage.
 - The complete DPM.
- (2) Development of the DPM equipment systems facilitated DPM verification

As a result, DPM could be used in every area (all design departments, analysis department, manufacturing department, etc.). The aim henceforth is to promote the usage of DPM and other sophisticated technologies so as to conform to various laws and regulations, and to further reduce the weight of vehicles considering the global environment.

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