



# *Development of Process and System to Create a High Accuracy and Large-scale Noise and Vibration Analysis Model of Car Body to Shorten the Design Period*

Hiroshi Shimada

Advanced Safety and NVH Development Group

Advanced Vehicle Engineering Dept.

Nissan Motor Co., Ltd.

PRODUCT DEVELOPMENT CONFERENCE



# Abstract



- Title:** Development of Process and System to Create a High Accuracy and Large-scale Noise and Vibration Analysis Model to Shorten the Design Period
- Authors:** Hiroshi Shimada, Morio Suzuki, Toru Matsui, Nobuhiko Takahashi, Hao Liu, Kazuyuki Saiga, Tooru Takahashi, Hirotaka Noguchi, Koji Nojima
- Company:** Nissan Motor Co., Ltd.  
1-1, Morinosatoaoyama, Atsugi-shi, Kanagawa 243-0123, Japan  
+81-46-270-3663
- Abstract:** Predicting the noise and vibration performance of a trimmed body with an analysis model is an essential method to reduce the vehicle development period. The application of a large-scale FEM enabled prediction of high accuracy; however, in order to utilize it at product development, a problem still remained that building an analysis model takes too much time. Here, we will introduce the solutions in which we successfully reduced the period dramatically after reviewing the model building process and utilizing the automatic processing.



# Agenda



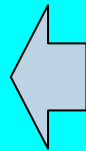
- **Background Efforts**
- **Problem in creating car body noise and vibration FE model**
- **Perspective in reducing model creation time**
- **Process and system for collecting required information to create the model**
- **Auto trim-up system**
- **Summary**



# ***Background : Application of CAE to Shorten the Design Period***



**Achieve high  
quality design  
in a short period  
of time**



**Rational structure  
change based on  
the mechanism  
of a phenomenon**



**Apply  
performance  
prediction  
with CAE**

**Betterment in the “quality of analysis  
investigation” is required**



# Background: Quality of Analysis Investigation



- Quality of Analysis : 1) Predictive accuracy of the analysis model  
Investigation
- 2) Length of period per cycle of the analysis investigation

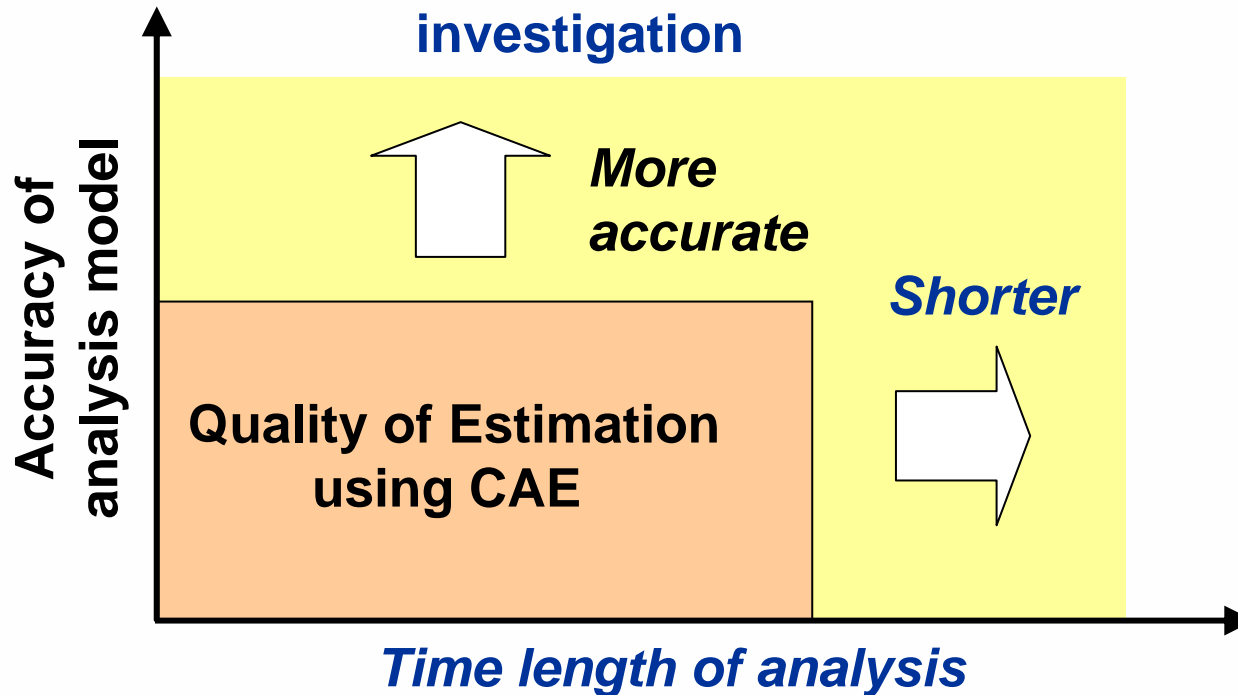


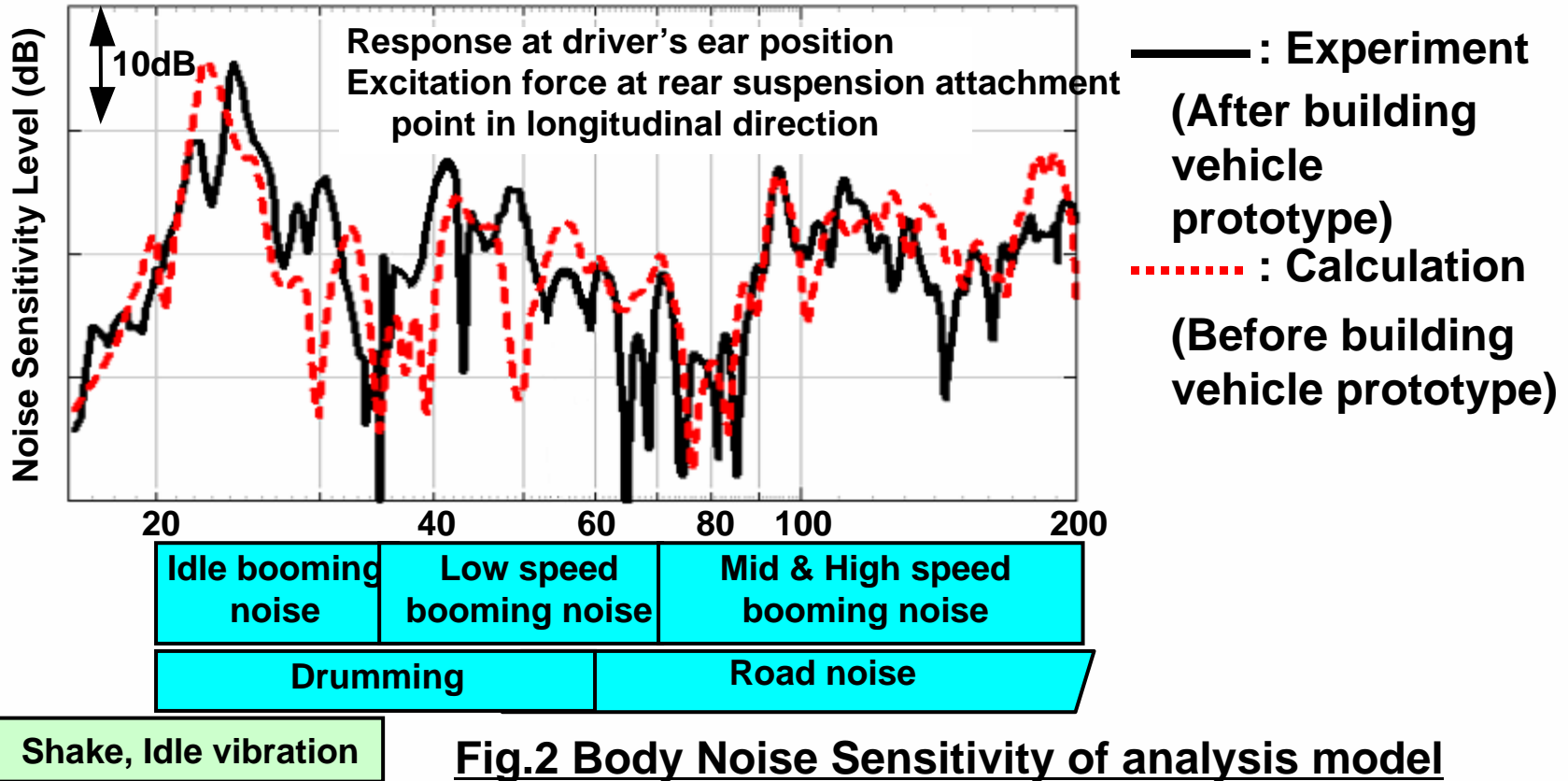
Fig.1 Quality of estimation using CAE



# Background : High Accuracy Car Body FE Model



Noise up to around 200Hz are predictable with high precision before building vehicle prototype with MSC.Nastran



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# Background : Problem in High Accuracy Car Body FE Model



Assure  
high  
predictive  
accuracy



Detailing and  
large scaling  
of model  
(1 million nodes)



Significant  
increase of analysis  
investigation period

=

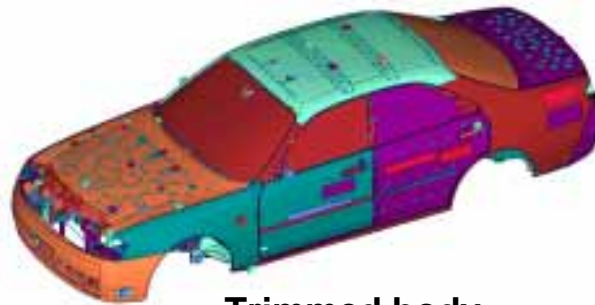
Deterioration  
of quality of  
analysis  
investigation

Shortening of analysis period is required

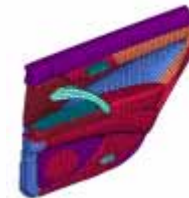
Cavity



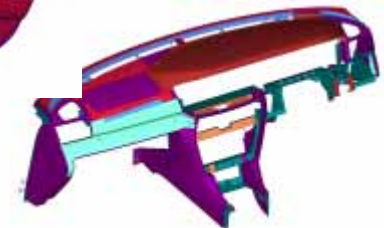
Small trim parts modeled by mass



Trimmed body



Door finisher



Instrumental panel

**Fig.3 High Accuracy and Large-scale Noise and Vibration Analysis Model of trimmed body**



# Background : Focused Area for Shortening Analysis Investigation Period



Steps of analysis investigation	Operation
1) Create analysis model	- Modeling
2) Initial evaluation	- Computation
3) Extraction of primary factor	- Post-Processing (Data recovery)
4) Countermeasure investigation	- Model modification - Computation
5) Final confirmation	- Computation

Innovation in development process including the upstream design process flow is needed

Realization is possible in the technical development of the new computation methods, such as adoption of high speed CPU and computational algorithm

Fig.4 Steps of analysis investigation



# Problem in Creating Car Body FE Model for Noise and Vibration



Model creation period: **conventional = several months** ← significant deviation  
**target = several weeks**

Challenge:

- 1) Collect required information to create the model
- 2) Trim-up work
- 3) Create mesh

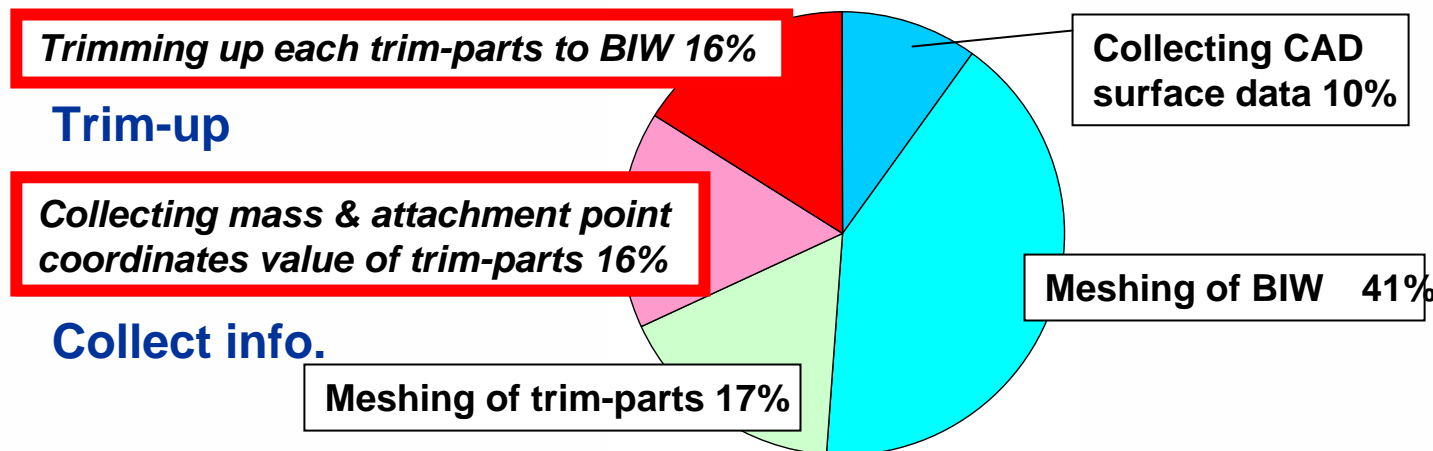


Fig.5 A breakdown of modeling time in past

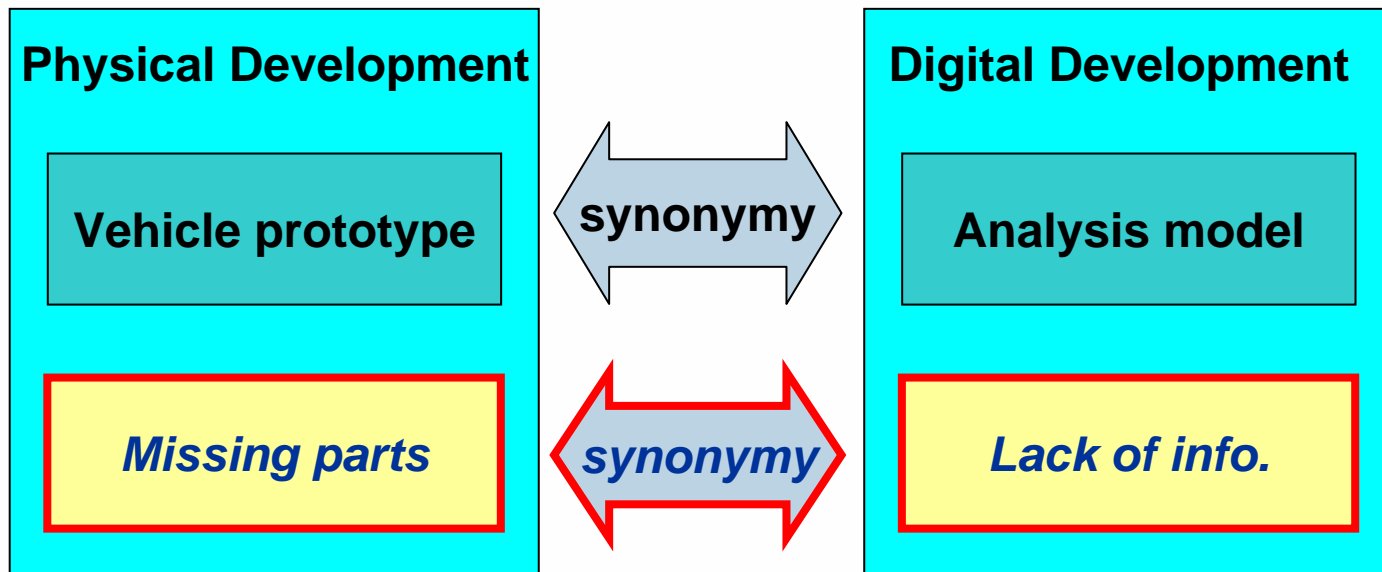


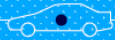
# Perspective in Shortening Model Creation Period : (1) Collect Required Information to Create the Model



**Conventional:** The analyst 'collected' the required information to create the model by asking the designers

**Ideal situation:** Information 'collect' to the analyst automatically



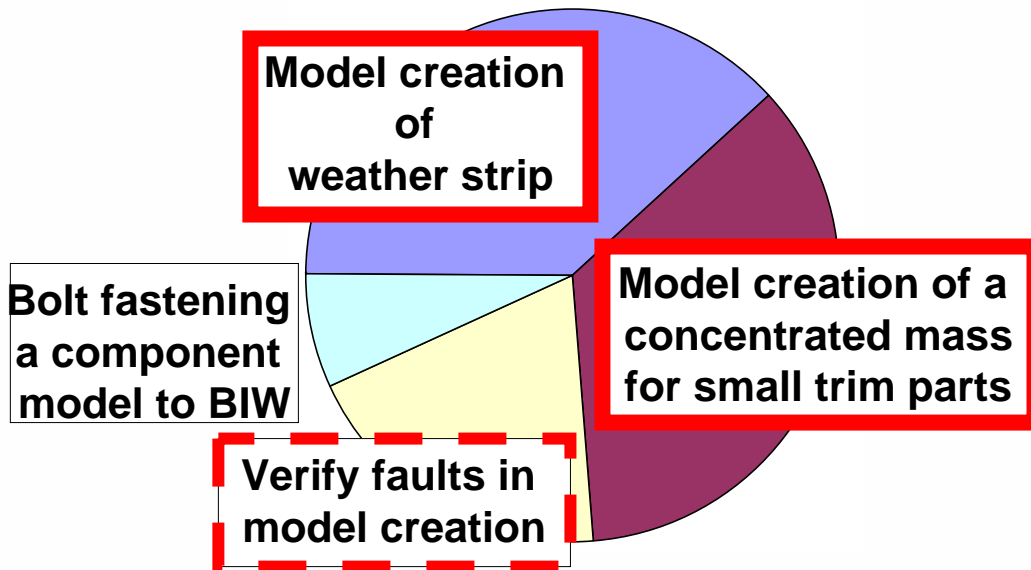


# Perspective in Shortening Model Creation Period: (2) Automate Trim-Up Work

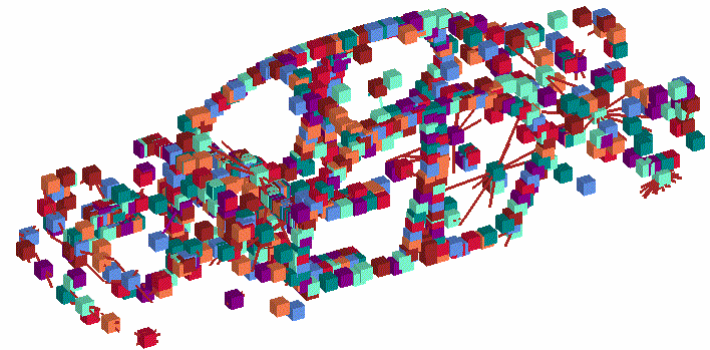


**Conventional:** Many works are frequently repeated with a regular procedure. Man-caused mistake may occur

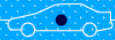
**Ideal situation:** Automate trim-up work and significantly shorten period



**Fig.7 A breakdown of trimming up time**



**Fig.8 Trim parts modeled by scalar mass** 10

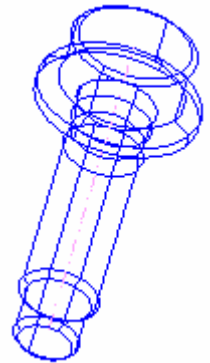


# ***Process for Collecting Required Information to Create the Model :***

## ***(1) Problem in Collecting Information***



- (1) The designers are not aware that what kind of information is required to create the model**
- (2) For example, the CAD data of an attachment hole and bolt shape is created though, numerical values such as coordinates required for model creation are not automatically detected and collected**
- (3) Can not verify if all of the required information to create the model is entered without any leak**





# Process for Collecting Required Information to Create the Model :

## (2) Development of Process and System



- (1) Clarify the required information to create car body FE model ... [i]
- (2) Input function of required information for model creation ... [ii]
- (3) Function and process to check a leak of input information ... [iii],[iv]

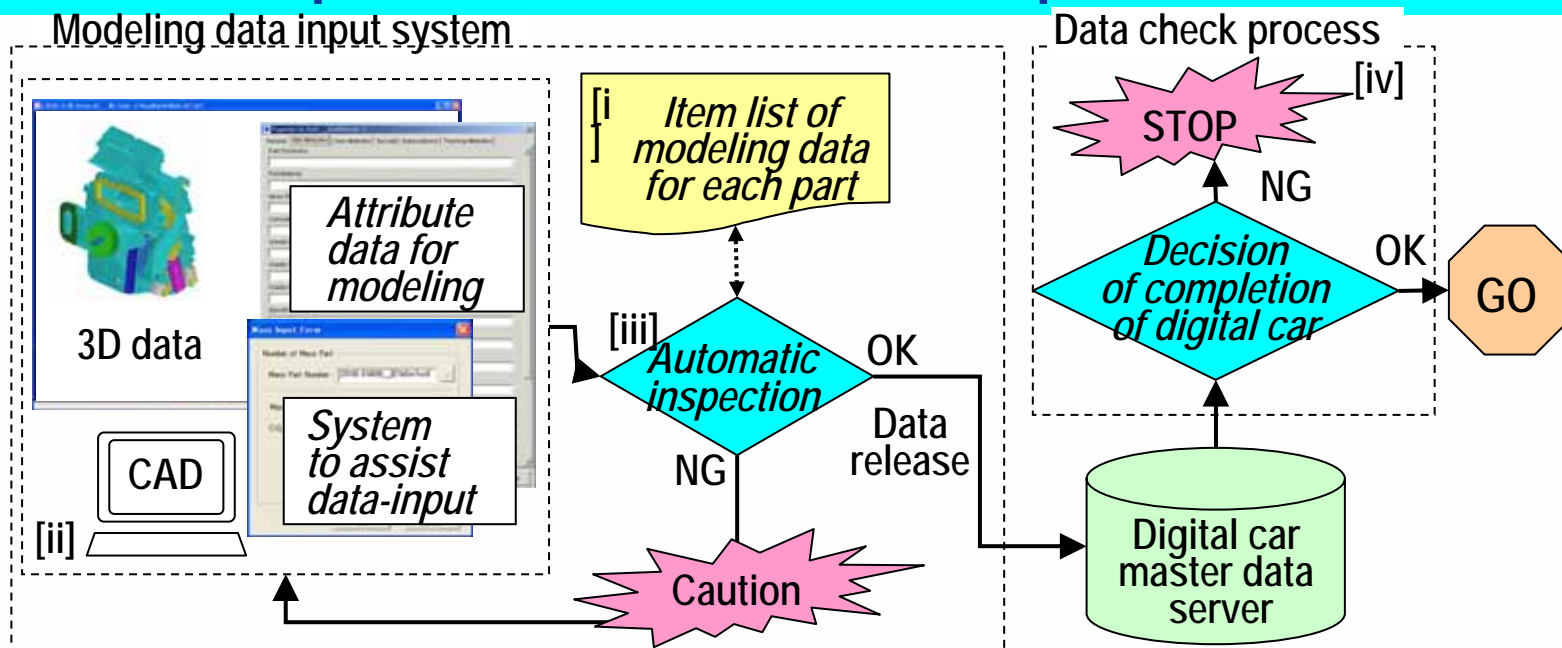
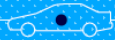


Fig.9 Developed modeling process and system to shorten modeling period



# Auto Trim-Up System



System is developed for the below 2 items which make up approximately 70% of the trim-up work period

- 1) Automatic creation system of a small trim parts
- 2) Automatic creation system of a weather strip

Create models of all parts in a few minutes

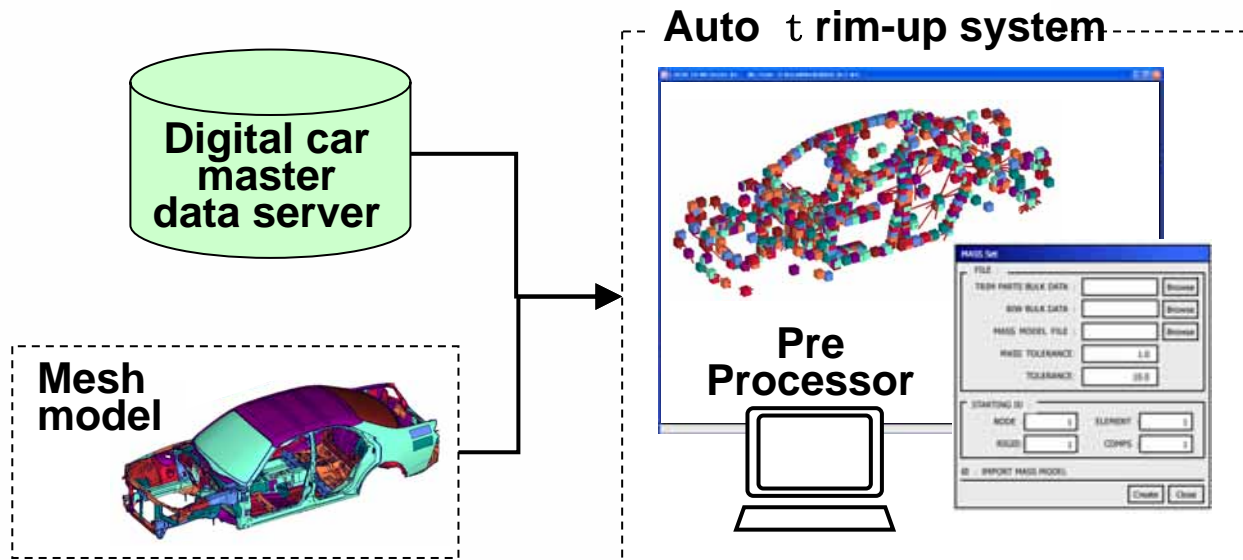
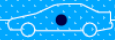


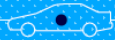
Fig.10 Developed auto trim-up system to shorten modeling period



## Summary



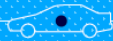
1. Clarifying problems/concepts for realizing the shortening of development period by applying high accuracy car body model for noise analysis to product design; with the below 3 tactics, the model creation period is roughly cut down to 1/4
  - i) New process and system is developed to collect required information for model creation at the same time of completion of the digital concept car
  - ii) Auto trim-up system was developed to create model in a short period based on model creation information
  - iii) The above process/system was applied to the product development



## ***Summary (Cont.)***



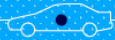
2. Furthermore, with the development of high speed computation algorithm and adoption of high speed CPU (not mentioned here), the analysis investigation period could be shortened to several weeks. This give a contribution in shortening the design period.



# References



- (1) Kenji Takada et.al., “Development of New Pre-Processor for Car Body Analysis,” Proceedings, of 2002 JSAE Annual Congress, JSAE, 2002, No.28-02, pp.5-8.
- (2) Katsuro Fujitani, “Present Status and Future Scope for Simulation in Car Development,” Journal of Society of Automotive Engineers of Japan, Vol.55, 2001, pp.4-8.
- (3) Nobuhiro Tsuchie, “Development of Body Acoustic Sensitivity Analysis Technique,” Proceedings, JSAE Symposium ”Has CAE Really That Much Contributed to the Change of Vehicle Development Process!?” , JSAE, 2004, No.08-04, pp.58-63.
- (4) J. K. Bennighof, et al., “Implementing Automated Multi- Level Sub-structuring in Nastran Vibro-acoustic Analysis,” Proceedings, of SAE 2001, SAE, 2001, 01-1405.
- (5) Vanderplaats Research & Development, Inc., “SMS - A High Performance Eigenvalue Solver,” <http://www.vrand.com/smswhitepaper.pdf>, 2001
- (6) P. Murthy, et al., “Automated Component Modal Synthesis with Parallel Processing,” <http://www.mscsoftware.com/support/library/conf/auto00/p03900.pdf>, 2000



**Thank you for your attention.**

**If you have any question, please contact me by e-mail.**

**E-mail : [hiroshi-s@mail.nissan.co.jp](mailto:hiroshi-s@mail.nissan.co.jp)**

**I would like to welcome questions.**



# Manual of Required Information for Model Creation



Microsoft PowerPoint

すべて既読の付いたアイテム

ファイル 編集 表示 挿入 書式 ツール スライドショー ウィンドウ ヘルプ

MS PowerPoint 24 75%

2 LOCK & RC ASSY-RR DOOR,RH/LH #2500/1 AX001

3 GRIP ASSY-RR DOOR O/S HANDLE,RH/LH #0640/1 AX004

4 FIN ASSY-RR DOOR,RH/LH #2900/1 AX002

5 HARN DOOR,FR,RH/LH #24126 AX000

6 SPEAKER UNIT,6.5 INCH #28156

7 CHECK LINK ASSY-RR DOOR,RH/LH #2431

8 MOTOR ASSY-RR DOOR,REG,RH/LH #2730

9 WSTRIP ASSY-RR DOOR,RH/LH #2831 AX000

10 WSTRIP-RR DOOR PTN GLASS,RH/LH #2273 AX000

11 HARN-ENG ROOM #24012 AX101

12 HANDLE ASSY-DOOR INSIDE,RH/LH #0670/1 AX12/13

13 HARN BODY #24014 AX002

14 HARN MAIN #2410 AX101

15 CANISTER ASSY-EVAP #4950 AX000

16 CABLE COMPL HOOD LOCK CONT #69621 AX000

17 ROD HOOD SUPT #6571 AX000

18 STAY ASSY-FR SUSP MBR #544C4

19 MBR ASSY-FR SUSP #54401

20 FIN ASSY-BACK DOOR #9090 AX000

21 CLOSURE COMPL TRUNK LID #84622

22 LOCK COMPL TRUNK LID #84631

23 LOCK ASSY HOOD #69612

24 STRIKER ASSY HOOD LOCK #69610

25 MOTOR COMPL BACK WDW WIPER #82000 17385

26 ARM COMPL BACK WDW WIPER #28780 AX000

27 TUBE ASSY-BACK WDW WASH #28975 AX000

28 STAY ASSY-BACK DOOR,RH/LH #90450 AX000,90451 AX000

29 HANDLE ASSY-BACK DOOR O/S #90606 AX000

30 WSTRIP-BACK DOOR #9030 AX000

31 LAMP ASSY-STOP,HIGH MTG #26590 AX000

32 HARN BACK DOOR #26590 AX000

33 FIN ASSY-DASH SIDE,RH/LH #66900,66901 AX000

34 ADJ STAY BELT,RH/LH #87824 AX000/1

35 BELT SET-FR SEAT PRETENS,RH/LH #06880/1 AX500

36 BELT ASSY-TONGUE,RR,RH/LH #88844

MODULE ASSY-AIR BAG,ASST (96515)

音振モデル化 衝突モデル化 必要CAD\_DATA

音振モデル化 衝突モデル化 必要CAD\_DATA

FIN ASSY-RR DOOR,RH/LH #2900/1 AX002

音振モデル化 衝突モデル化 必要CAD\_DATA

説明:  
重心位置に集中  
集中マスと取付  
(RBE2)で接続

説明:  
メッシュ

説明:  
メッシュモデル

ボス、リブも表現必要  
材料データ例は、速度依存を含めたS-S  
カーブ

形状すべて 3D CAD (管、面)  
板厚 (管、面)  
材料定数 (管、面)  
速度依存を含めたS-Sカーブ (面)  
部品結合位置 (管、面)  
結合方法 (クリップ、ボルト、溶着)  
(管、面)

754 F 4 / 168 標準デザイン



# Operation Manual of Required Information Collecting System for Model Creation



取付け点入力マニュアル - Microsoft Internet Explorer の標準元 - NISSAN MOTOR CO.,LTD

ファイル(F) 編集(E) 表示(V) お気に入り(I) ツール(T) ヘルプ(H)

アドレス http://

**取付け点入力 作業手順**

- 取付け点入力プログラムの起動
- 取付け点の入力
- 入力情報の確認
- 入力情報の保存
- 保存情報の送付

**番外編**

- 取付け点位置の移動
- 取付け点位置の削除
- 取付け点情報の追加
- 質量の変更
- 保存情報の読込
- 部品の取出し、格納

3. Part, Part Instance, Assembly Instance がワークベンチ上から選択可能になります  
取付け点を入力する部品を選択して下さい

【選択方法:1】ワークベンチ上から直接部品を選択することができます  
!ただし、意図しない部品を選択してしまう可能性があるため、注意が必要です

左クリックで部品選択

真ん中クリックで決定

選択した部品の部品番号が欄に入力されますので確認してください

**おすすめ**

【選択方法:2】部品番号を見ながら部品を選択することができます  
! Assemblyをワークベンチ上に表示している場合の時のみこの方法で部品を選択する事ができます。

部品を選択する際にワークベンチ上で右クリックをします

Part Form

Input Part Information

Part Number : 21101 EN000\_KitbleTur0

Weight :

CG X :

Y :

Z :

Check

OK Cancel

VIS-表示  
LAB-ラベル  
2-図層  
PO-ピックのみ  
FIL-フィルタ...