HPC in Automotive and Appliance Industry
Especially in CAE field

WanHo Jeon
CEDIC Co., Ltd.

Contents

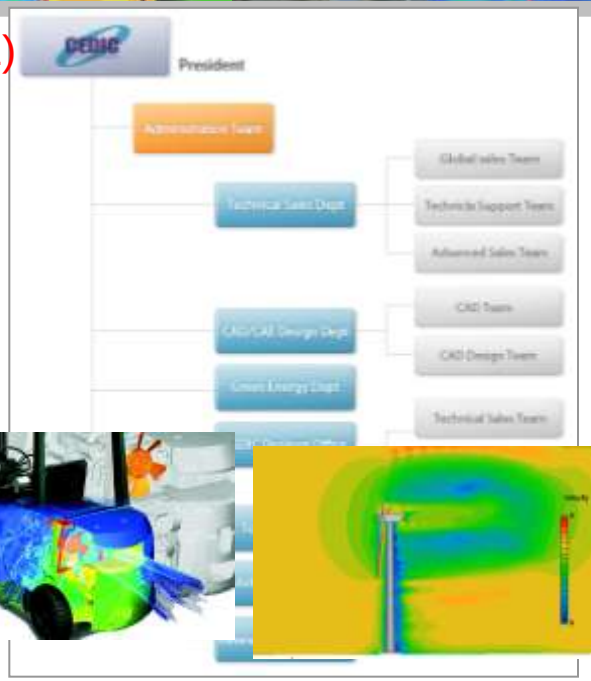
1. Introduction of CEDIC Co., Ltd.

- CEDIC Co., Ltd. (Concurrent Engineering Design using Intelligent CAE)
- Foundation : Feb. 2005
- Staff : 40 Persons
- Address : 12F Ace High-end Tower III Geumcheon-gu, Seoul,
- Business Field

  Developing engineering S/W

  Engineering consulting – Analysis, Design

  Engineering consulting in Japan (CEDIC Japan branch)



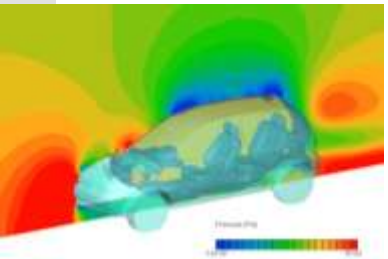
- Technologies

  Development of S/W and engineering solutions

  ▷ FlowNoise (Dipole and Quadrupole)

  ▷ FDS (Fan Design System)

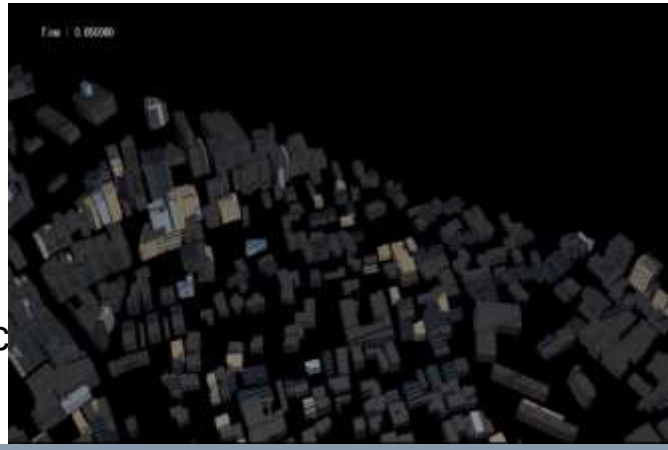
  ▷ Data Analysis, CDS (CAE Design System)



  Vehicle design using CAE

  Optimized green energy (wind, water, solar power etc.) effic

  Heat management technology in electronic components



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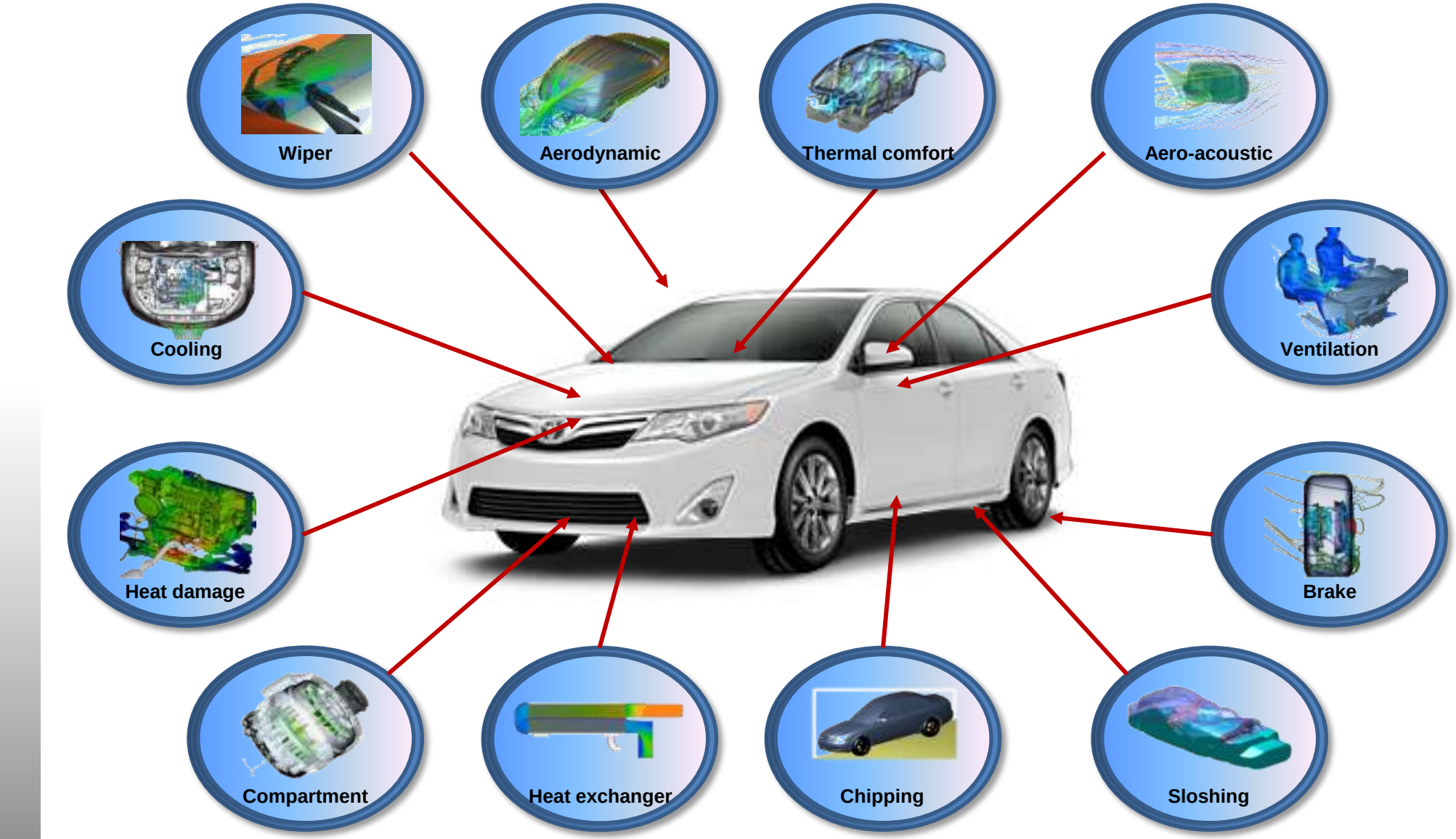

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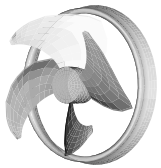
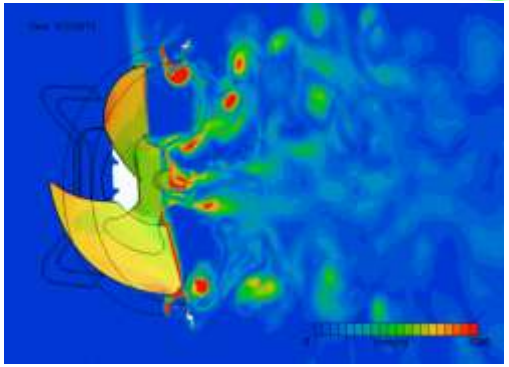
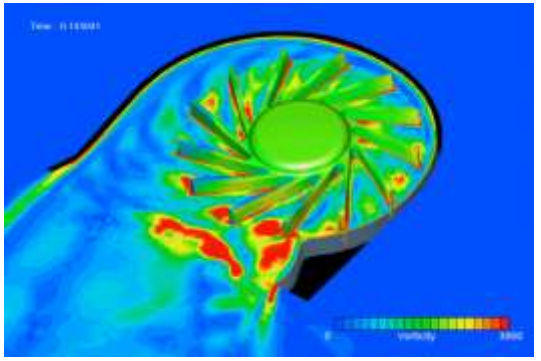
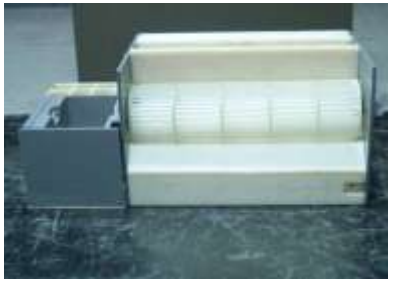


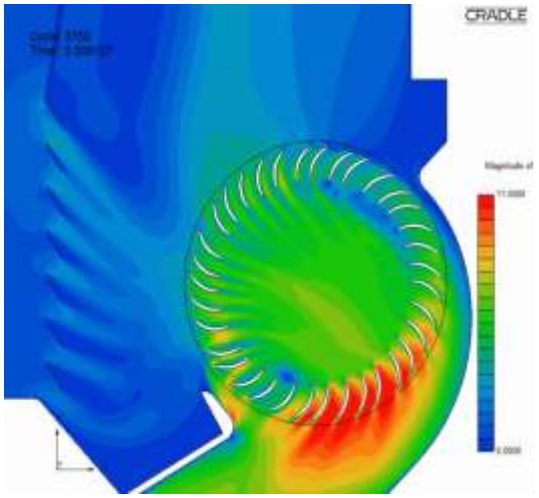


Axial fan



Centrifugal Fan





Cross flow fan

2. Current HPC Usage in Korean Industry

■ Current number of cpus and usage of HPC by major companies (Mechanical CAE field)

Company	Number of CPU retention (in Mechanical field)	Major Fields of HPC in mechanical field (%)					Total rate of usage (%)
		CFD	Structure	NVH	Crash	ETC	
Hyundai Motors Company	5,000	25	20	15	25	15	60
Samsung Electronics (Home Appliance)	1,000	20	50	15	-	15	80
Samsung Advanced Institute of Tech.	3,500	10	60	10	-	20	30
LG Electronics	1,000	10	50	10	-	30	60
Hyundai Heavy Industry	3,000	20	20	20	-	40	40

- Needs of HPC are gradually increasing since 2000.
  – Performance, Optimize, Replace proto-type test
- The usage of HPC have rapidly increased since 2010.
  - Use real CAD data. Replace Reliability test

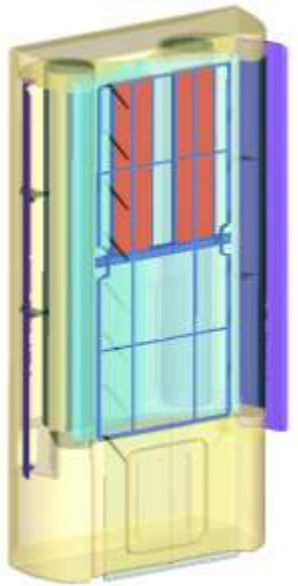
3. Major Analysis Issues

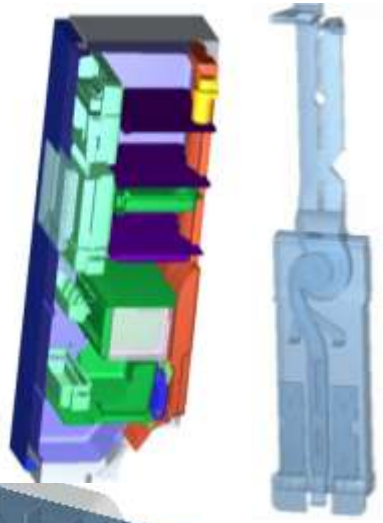
Automotive application > Aerodynamics

Aerodynamic design / Drag coefficient analysis / Aero-acoustic analysis

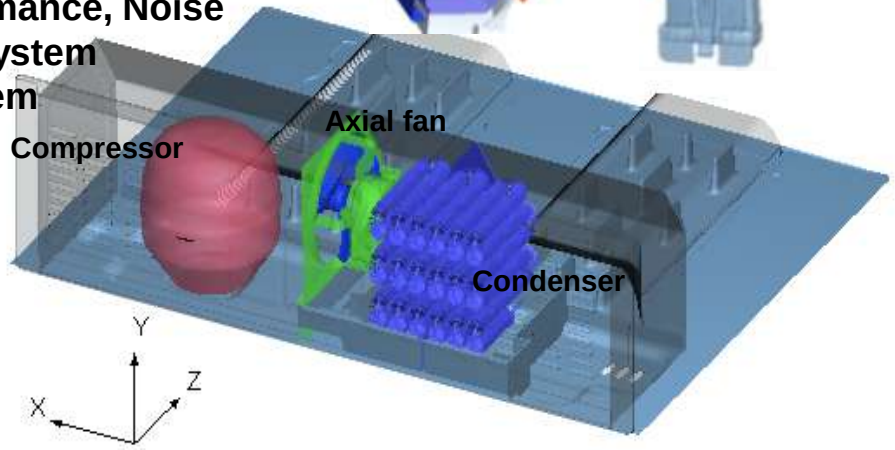
3. Major Analysis Issues

- ✓ Temperature uniformity
- ✓ Flow distribution of duct
- ✓ Fan performance, Noise
- ✓ Icing inside refrigerator
- ✓ Local cooling
- ✓ Optimize duct system





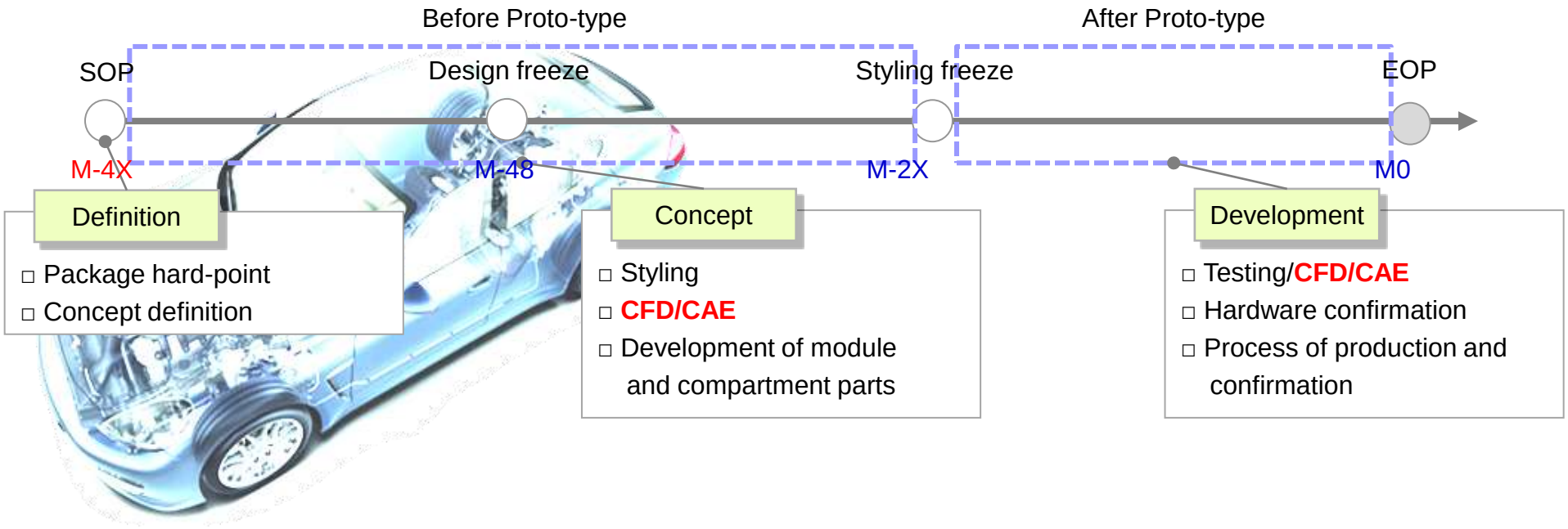
- ✓ Layout optimize
- ✓ Fan performance, Noise
- ✓ Compact system
- ✓ Heat problem



- ✓ Fan performance, Noise
- ✓ Cooling time minimize
- ✓ Local Targeting of air
- ✓ Dew condensation
- ✓ New duct system design
- ✓ Room analysis

4. Applications of CFD Analysis Techniques in Automotive Product Designing

Vehicle development process



■ Concept design stage : Predict the performance of the vehicle using CAD can help the designer

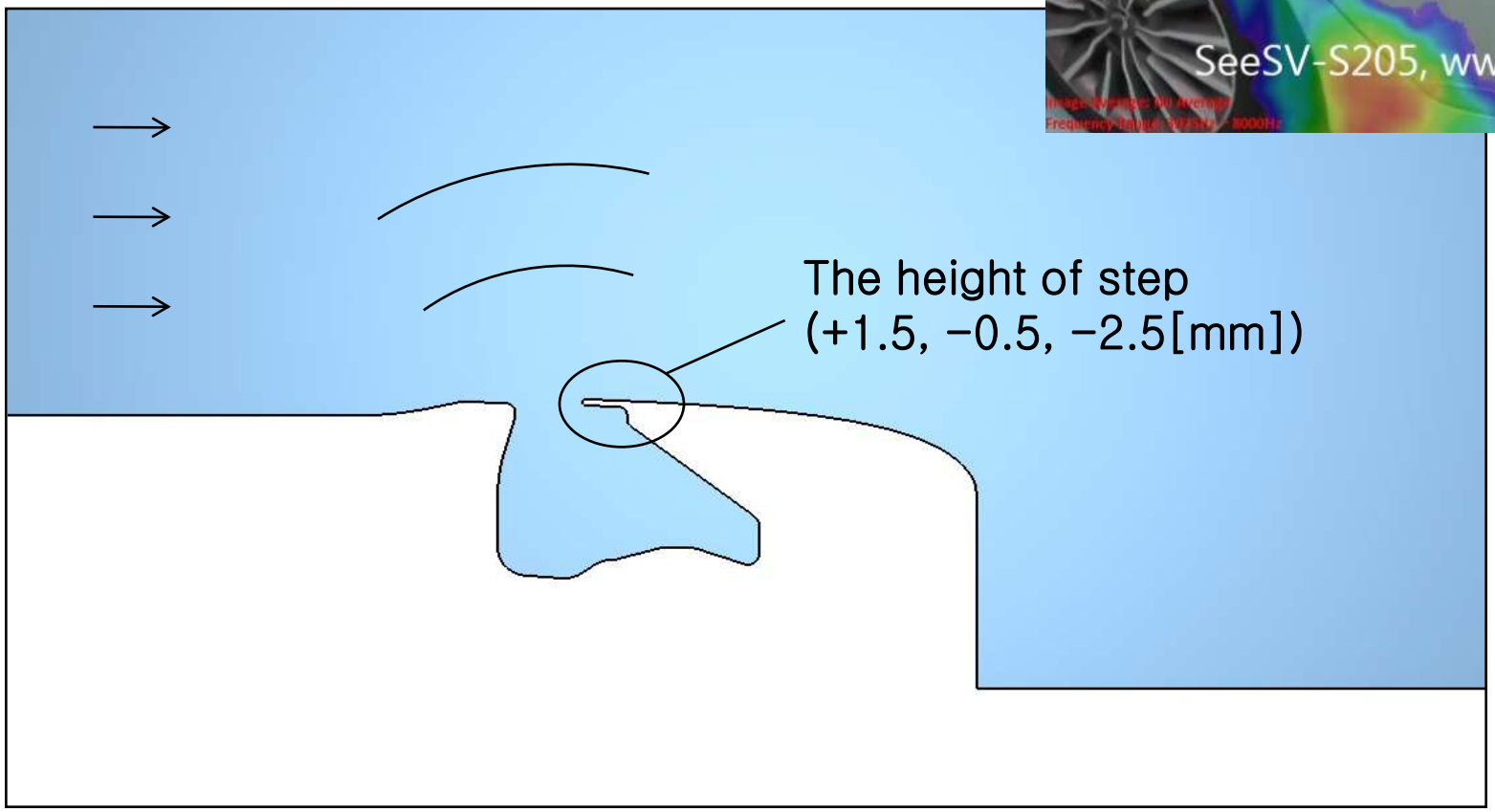
■ Development stage : CAE can be used in parallel with actual test. CAE can substitute the test in some particular fields

Major companies in automobiles, electronics, and heavy industries are currently applying “designing process using CFD/CAE” for reduction of time and cost for development.

4. Applications of CFD Analysis Techniques in Automotive Product Designing

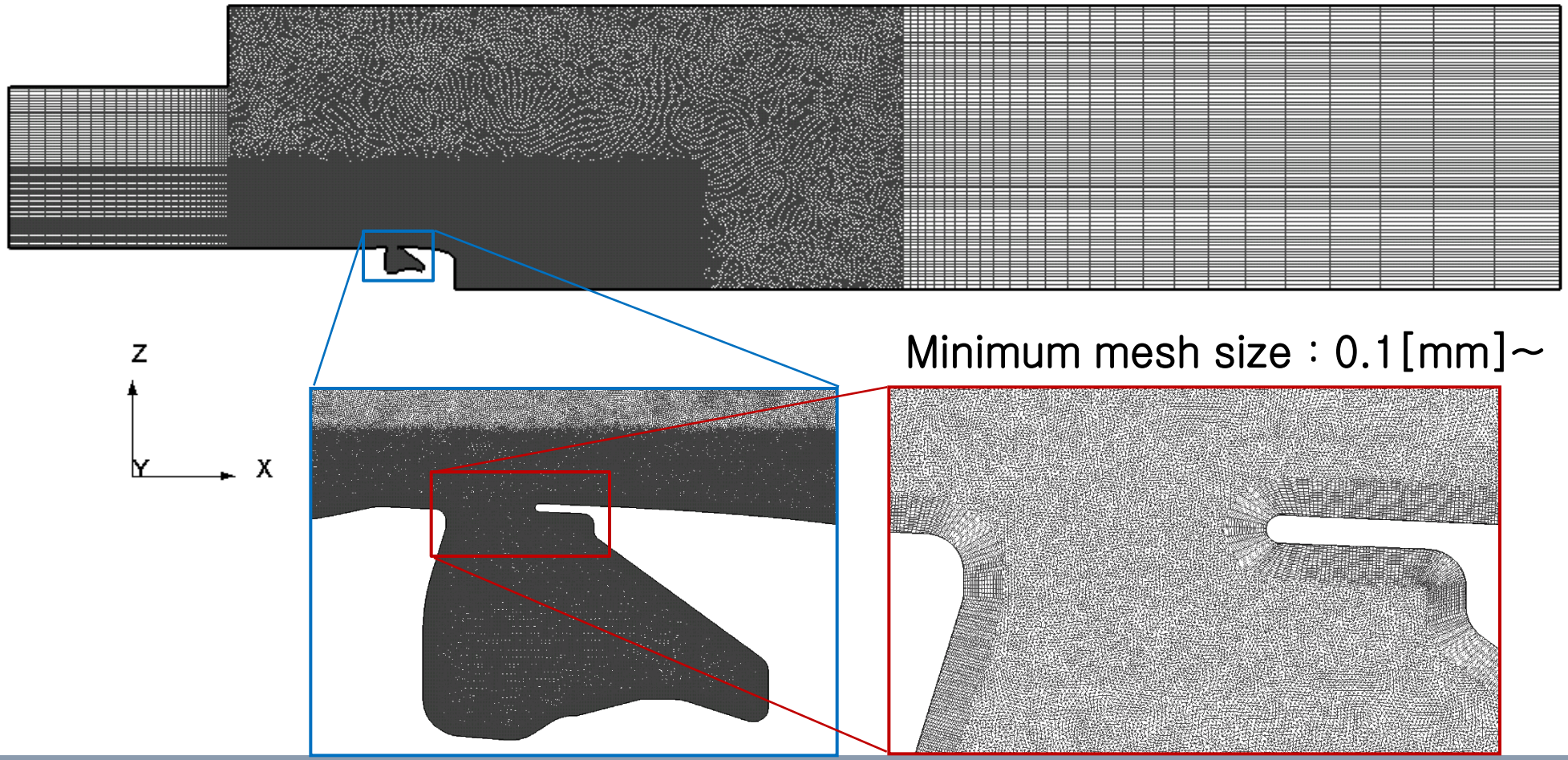
[Aero-acoustics application]

- The noise of vehicle connection area
  - By changing the height of step



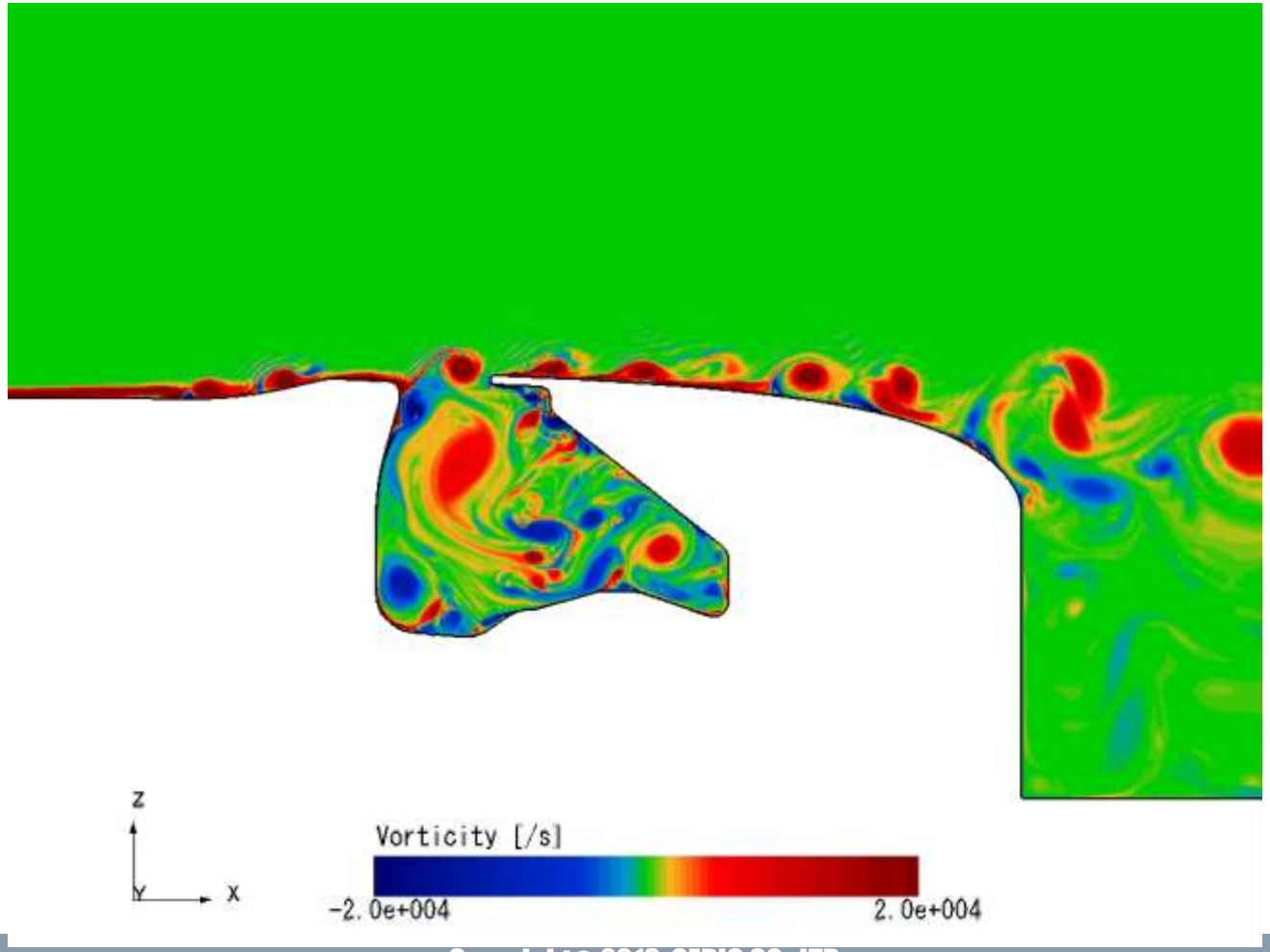
[Aero-acoustics application]

- Mesh structure
  - Sample : CASE1(+1.5[mm])



[Aero-acoustics application]

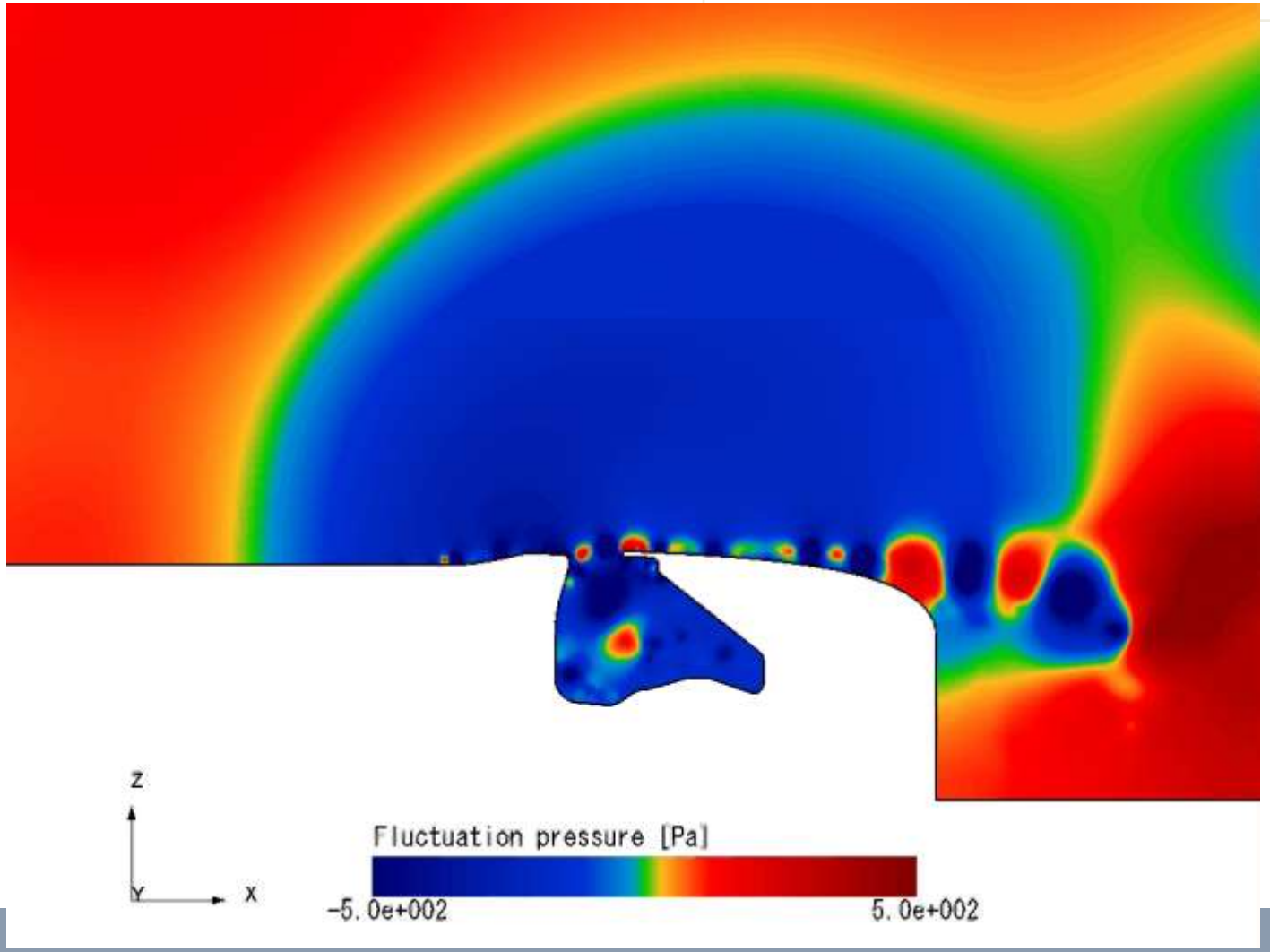
- Vorticity field (movie)
  - CASE1(+1.5[mm])



[Aero-acoustics application]

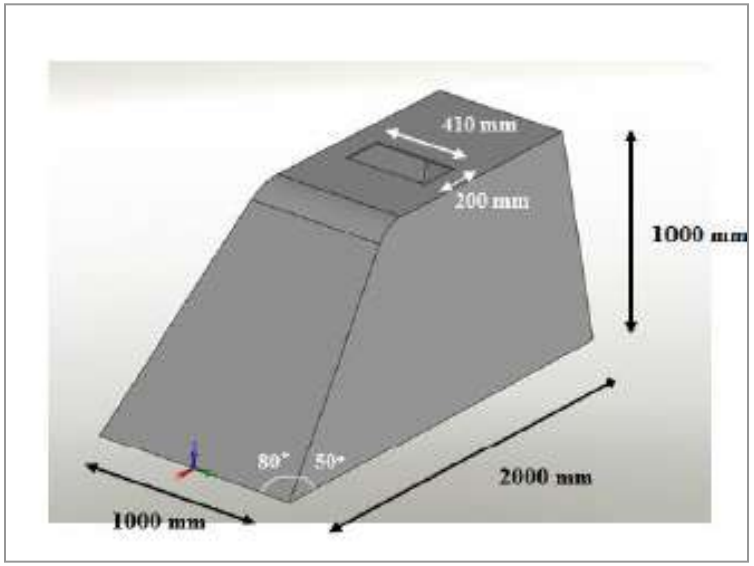
- Pressure fluctuation (movie)
  - CASE1(+1.5[mm])

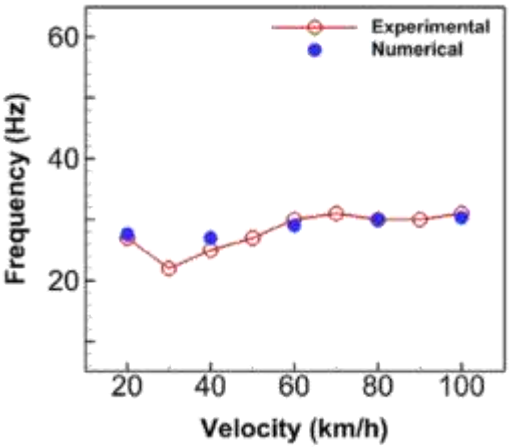
$$\Delta p = p - p_{ave} \quad p_{ave} = \frac{1}{T}\int_{t'}^{t'+T} p(t)dt$$

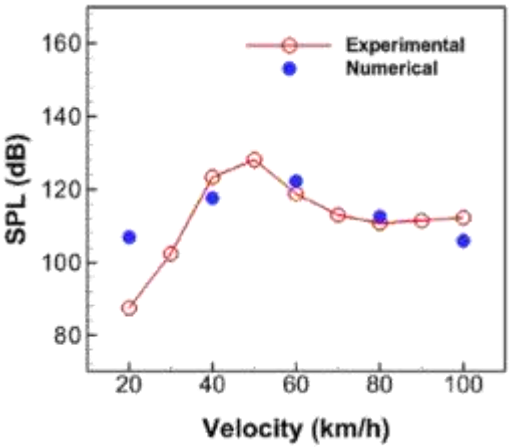


4. Applications of CFD Analysis Techniques in Automotive Product Designing

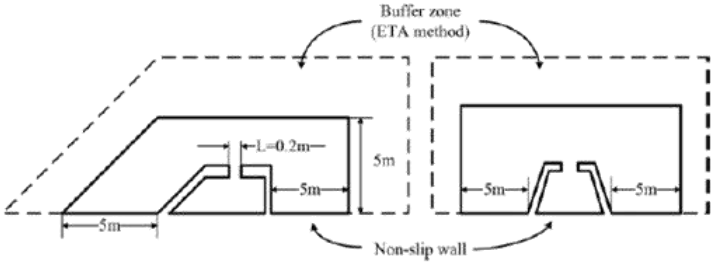
[Aero-acoustics application]



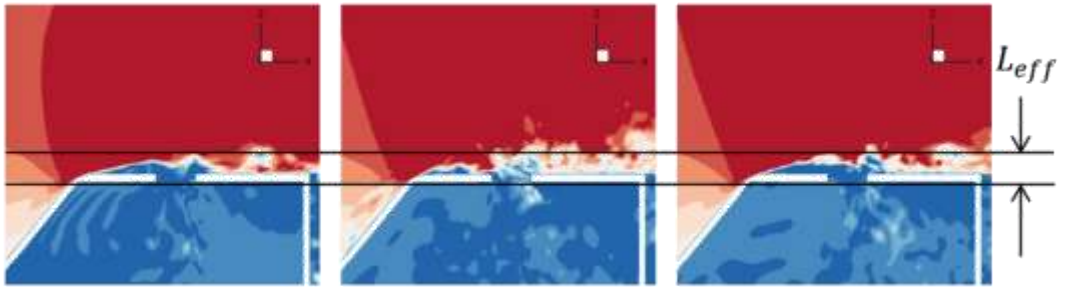




[Comparison of Peak frequency and SPL with variable velocities]



[computational grids and boundary conditions]

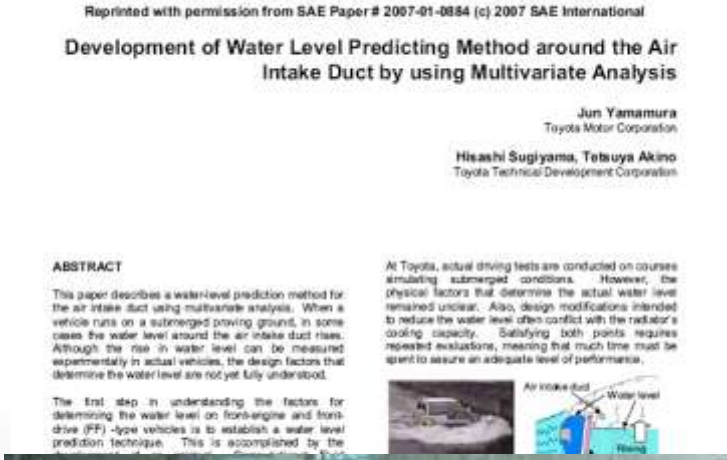


[20KPH] [60KPH] [100KPH]

■ Analysis of the noise characteristics of Ahmed body model (Experimental Data offered by HMC, 2013)

4. Applications of CFD Analysis Techniques in Automotive Product Designing

[Water Tunnel Test]



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Development of Water Level Predicting Method around the Air Intake Duct by using Multivariate Analysis

Jun Yamamura
Toyota Motor Corporation

Hisashi Sugiyama, Tetsuya Akino
Toyota Technical Development Corporation

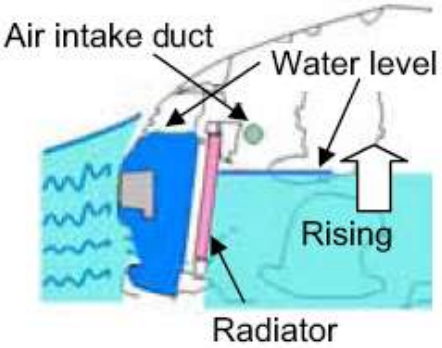
ABSTRACT

This paper describes a water-level prediction method for the air intake duct using multivariate analysis. When a vehicle runs on a submerged proving ground, in some cases the water level around the air intake duct rises. Although the rise in water level can be measured experimentally in actual vehicles, the design factors that determine the water level are not yet fully understood.

The first step in understanding the factors for determining the water level on front-engine and front-drive (FF) -type vehicles is to establish a water level prediction technique. This is accomplished by the

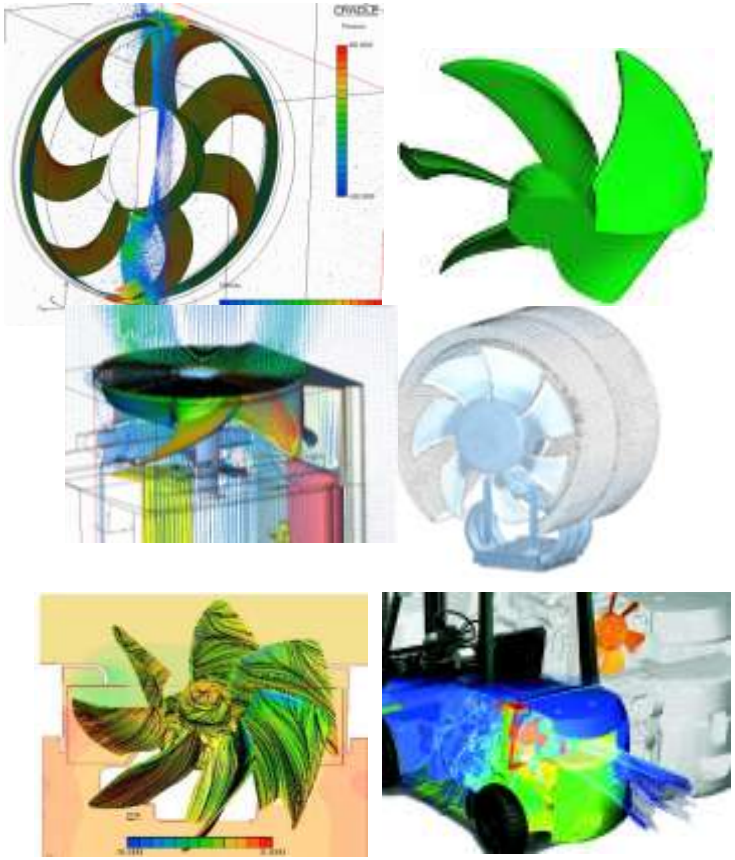
At Toyota, actual driving tests are conducted on courses simulating submerged conditions. However, the physical factors that determine the actual water level remained unclear. Also, design modifications intended to reduce the water level often conflict with the radiator's cooling capacity. Satisfying both points requires repeated evaluations, meaning that much time must be spent to assure an adequate level of performance.

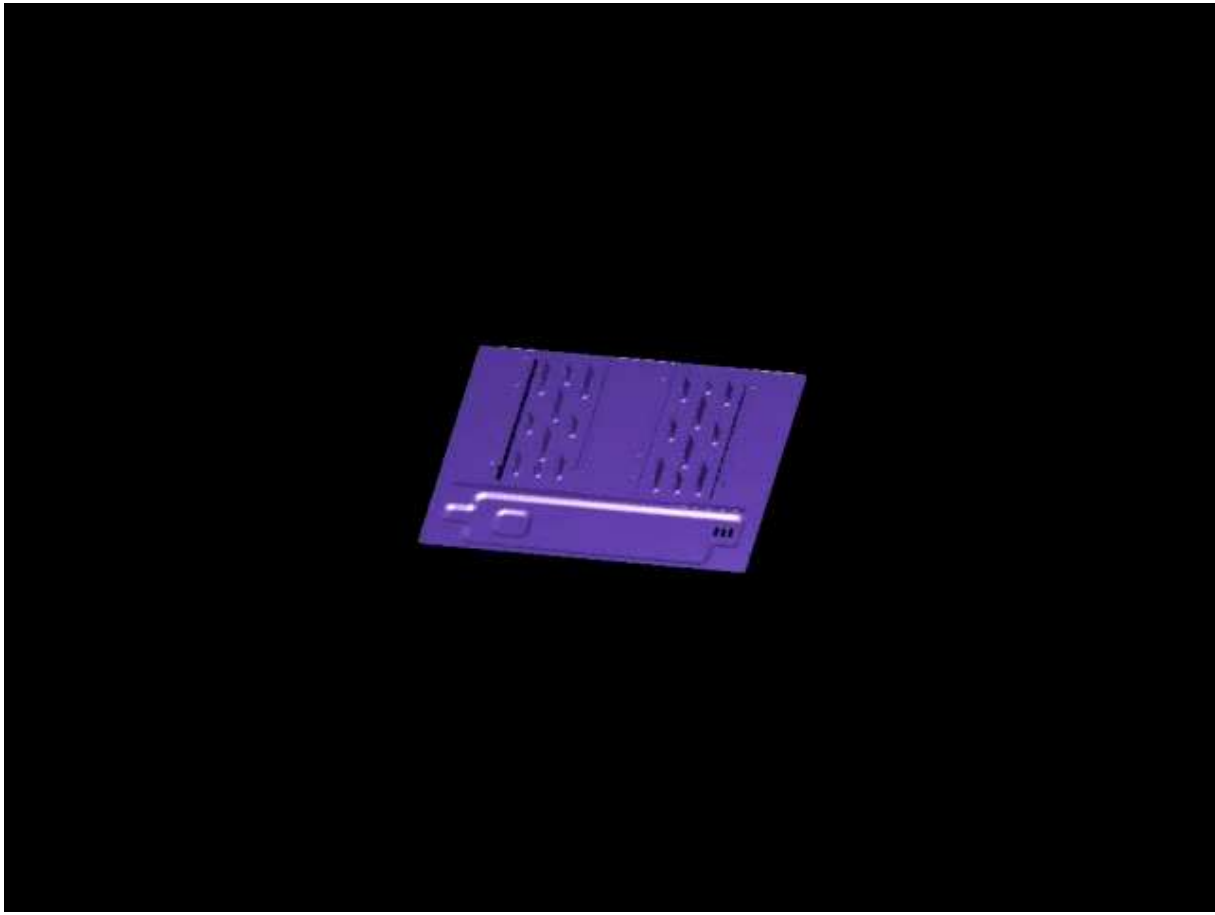
Submerged proving ground



5. CFD Analysis in designing appliances

Virtual Fan Tester





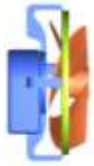
5. CFD Analysis in designing appliances

◎ CFD analysis should be one of the tool for "Product developing Process"

Making about 100 of sample (mock-up)
: takes several months and high cost
: Noise reduction study relies solely on engineering experience

Shape configuration using each companies' design tool
No information about noise reduction

Sample : 100 EA
Facility : needs several billion won
It takes several month for measure



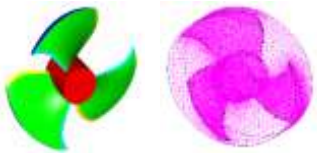
Concept Design (Digital Products)

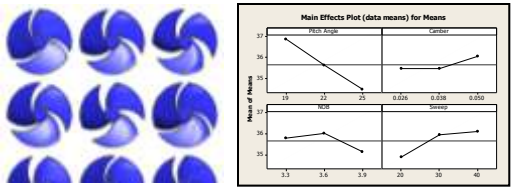
Make PT or CAE Process

Meet the Requirement

Test for confirm

Confirmation of noise change regarding to variation of shape
Providing guide of noise reduction





Parameter study
Object : performance, noise

More than 3 times shorten the developing process and cost

5. CFD Analysis in designing appliances

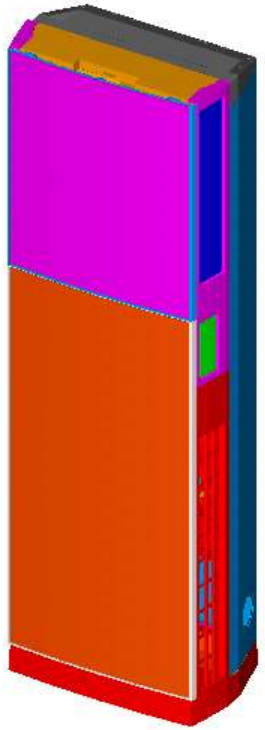
■ Sweat test for air-conditioner

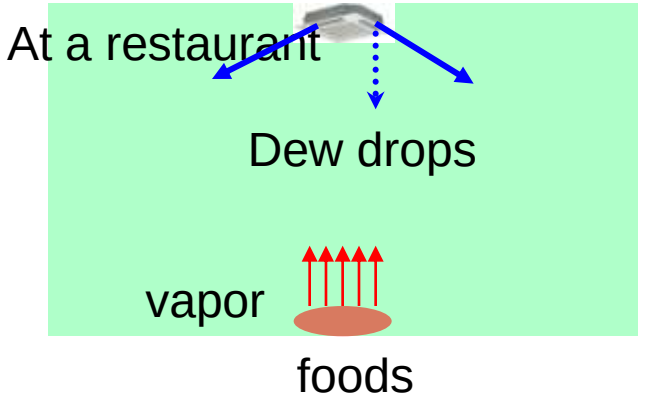
Numerical Study of Sweat Test for Air-conditioner Reliability

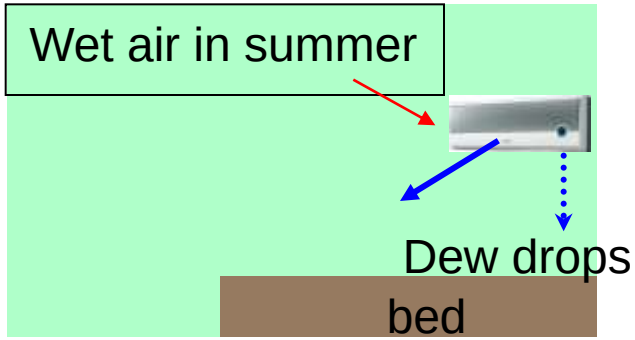
Tae-hun Kim*, Chul-ho Back, Seung-hun Yu, Young-tae Kim & Back youn

Air Conditioner R&D Team, Samsung Electronics, Suwon 443-742, Korea

Keywords : CFD (Computational Fluid Dynamics), Dentist, Air-Conditioner, PAC(Package Air





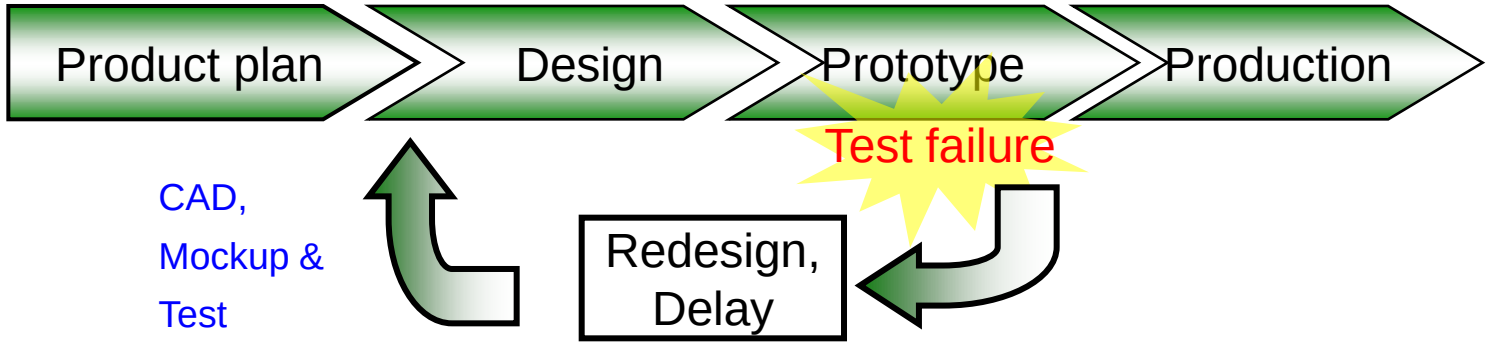


5. CFD Analysis in designing appliances

■ A test for reliability specification(KS C 9306) is performed after prototype development of an air-conditioner

■ If the prototype model fails at the sweat test, it requires total modification of the product which takes lots of cost and time

■ A technology for verification of dew condensation is required at the development planning step.

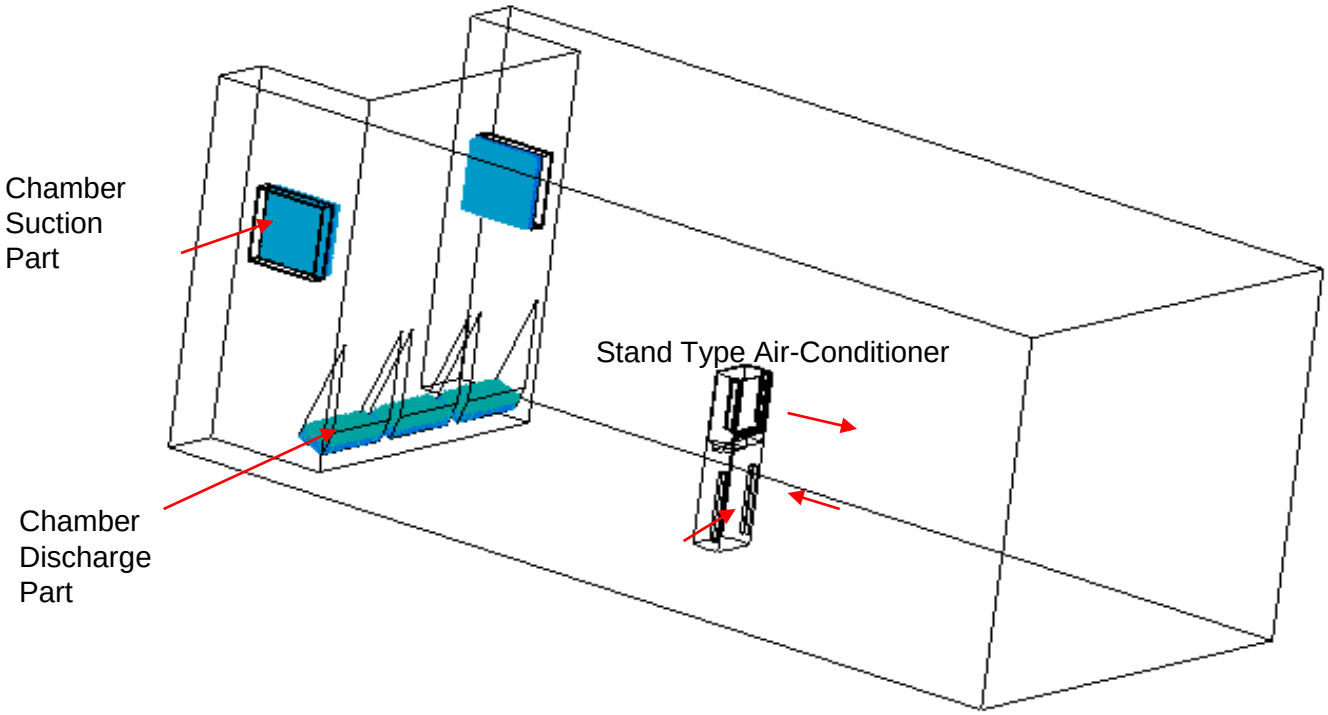


5. CFD Analysis in designing appliances

■ Sweat test for air-conditioners

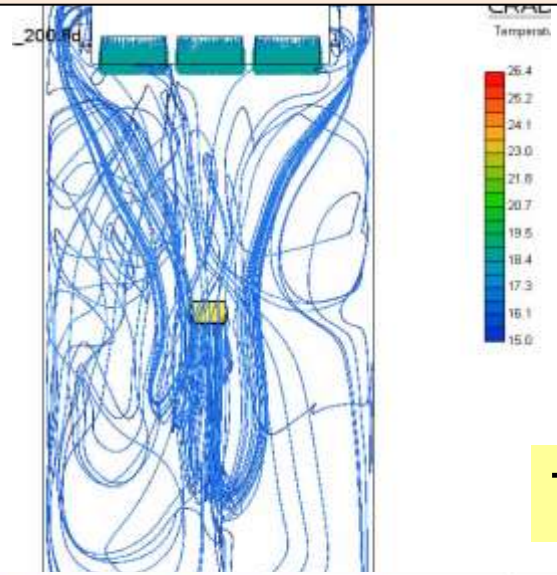
◣ CAE Boundary Condition

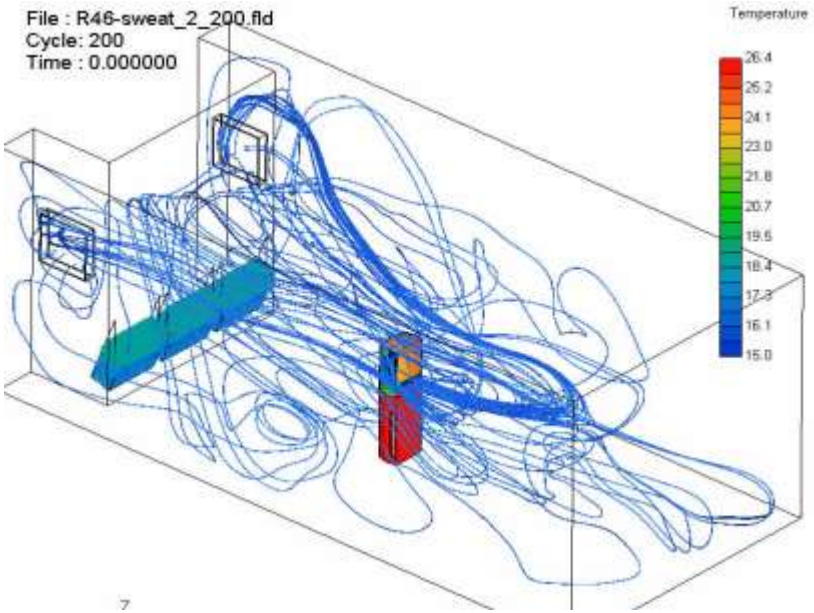
Test Room Modeling (Psychrometric Chamber)



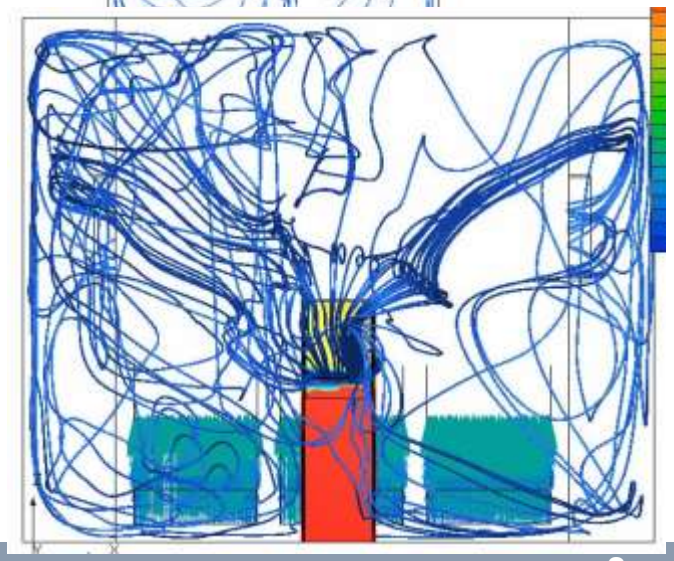
5. CFD Analysis in designing appliances

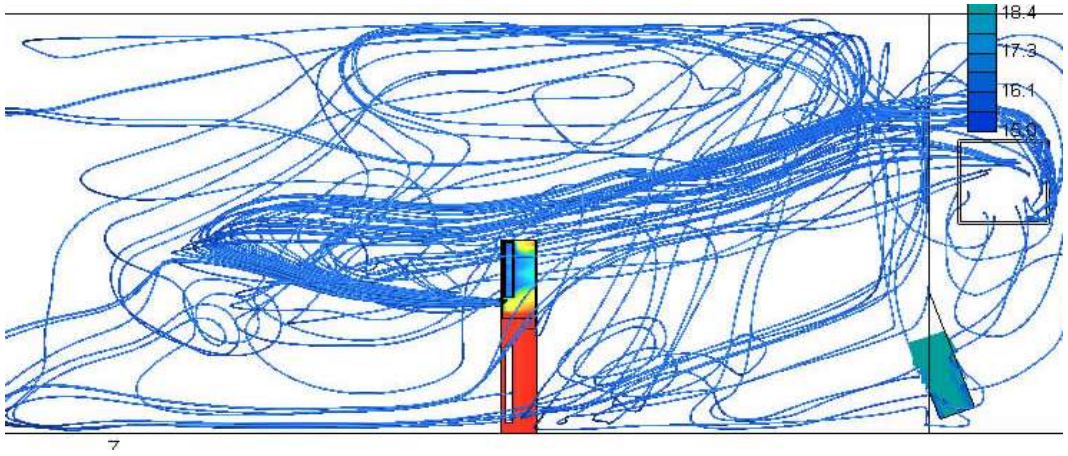
■ Sweat test for air-conditioners





Test room

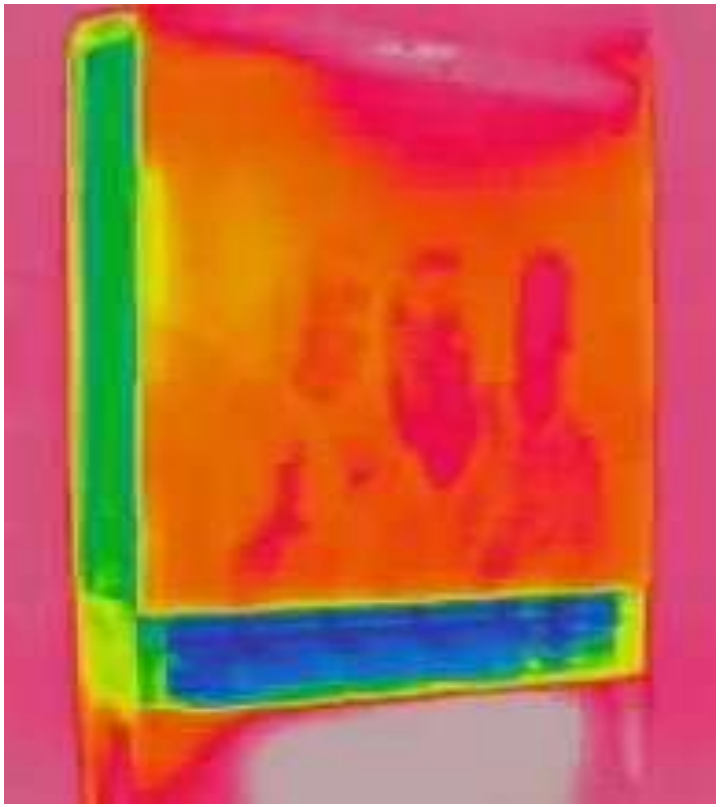




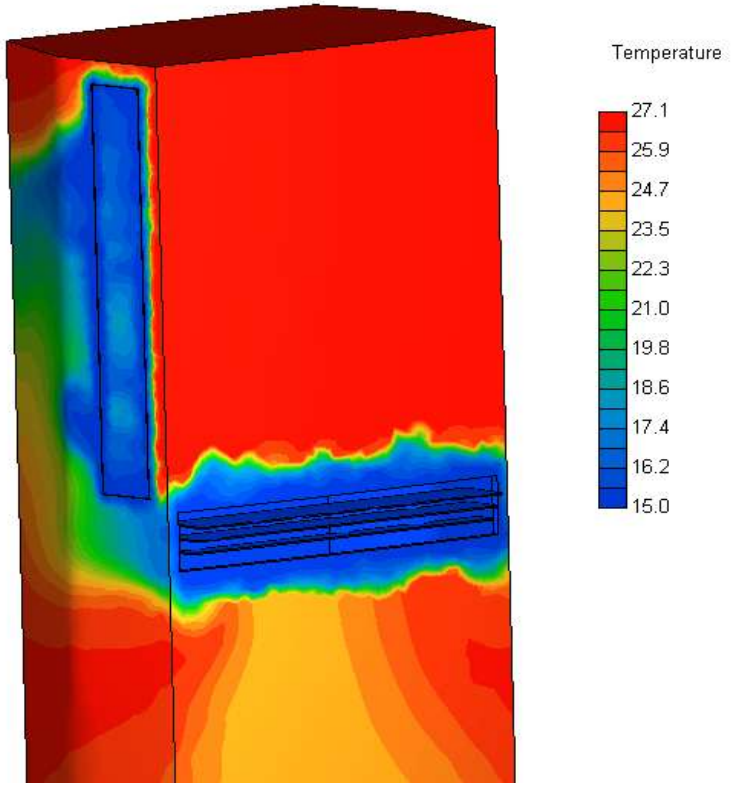
5. CFD Analysis in designing appliances

■ Sweat test for air-conditioners

Comparison of the surface temperature



Measure

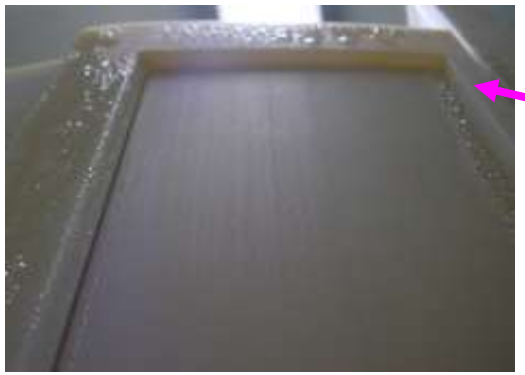


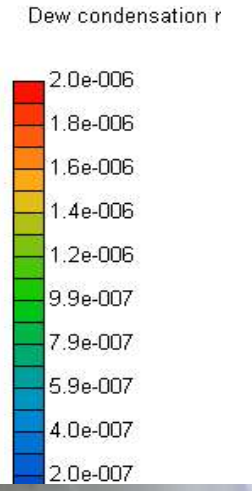
Numerical results

5. CFD Analysis in designing appliances

■ Sweat test for air-conditioners

Standard type air-conditioner
✓ CFD : SC/Tetra
✓ Test : IR Camera, PIV





6. Future : Automated Analysis System

Technology Drain

- **Problem of Young Engineers**
  - Companies worry about “Technology drain” (leaving of Design Engineers from manufacturing floor was one of the causes).
  - Many students don’t study the “Engineering”. They want to be a lawyer, doctor and government employee.

- **What is Thinking CAE?**
  - Light CAE for design engineers by automation process
  - Linked knowledge base database
  - The know-how and knowledge can be packed with software and transferred to younger people.
  - Design engineers can easily use CAE with design parameter and understand the cause-and-effect relationships.

6. Automated Analysis System

What is our strategy to success in worldwide

China, India, etc.

-Securing vehicle design and technology by reverse engineering
- Expanding fund for targeting worldwide market
- Introducing design technique using CAE
- Improving competitiveness of price with low labor cost

GM, Ford, Toyota , etc.

- Collecting data from experiment, analysis, etc.
- Fast designing of a vehicle using database
- constructing automated process of CAE analysis to replace actual test

Choice of Korean Industries

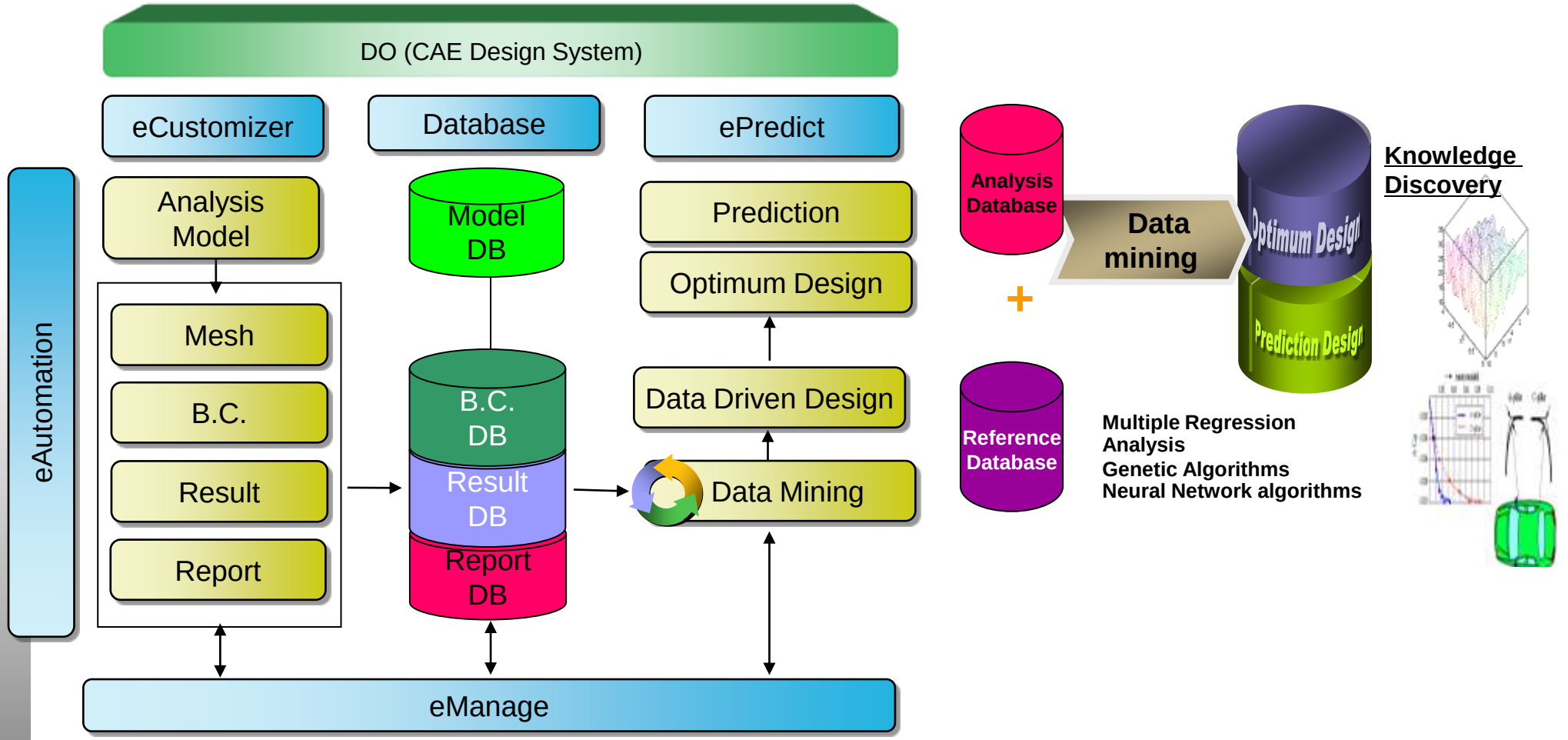
• Fast designing of a vehicle using database and automated CAE analysis

• Increasing competitiveness by prior occupation of technology

• Ensuring competitive price by reducing designing and producing

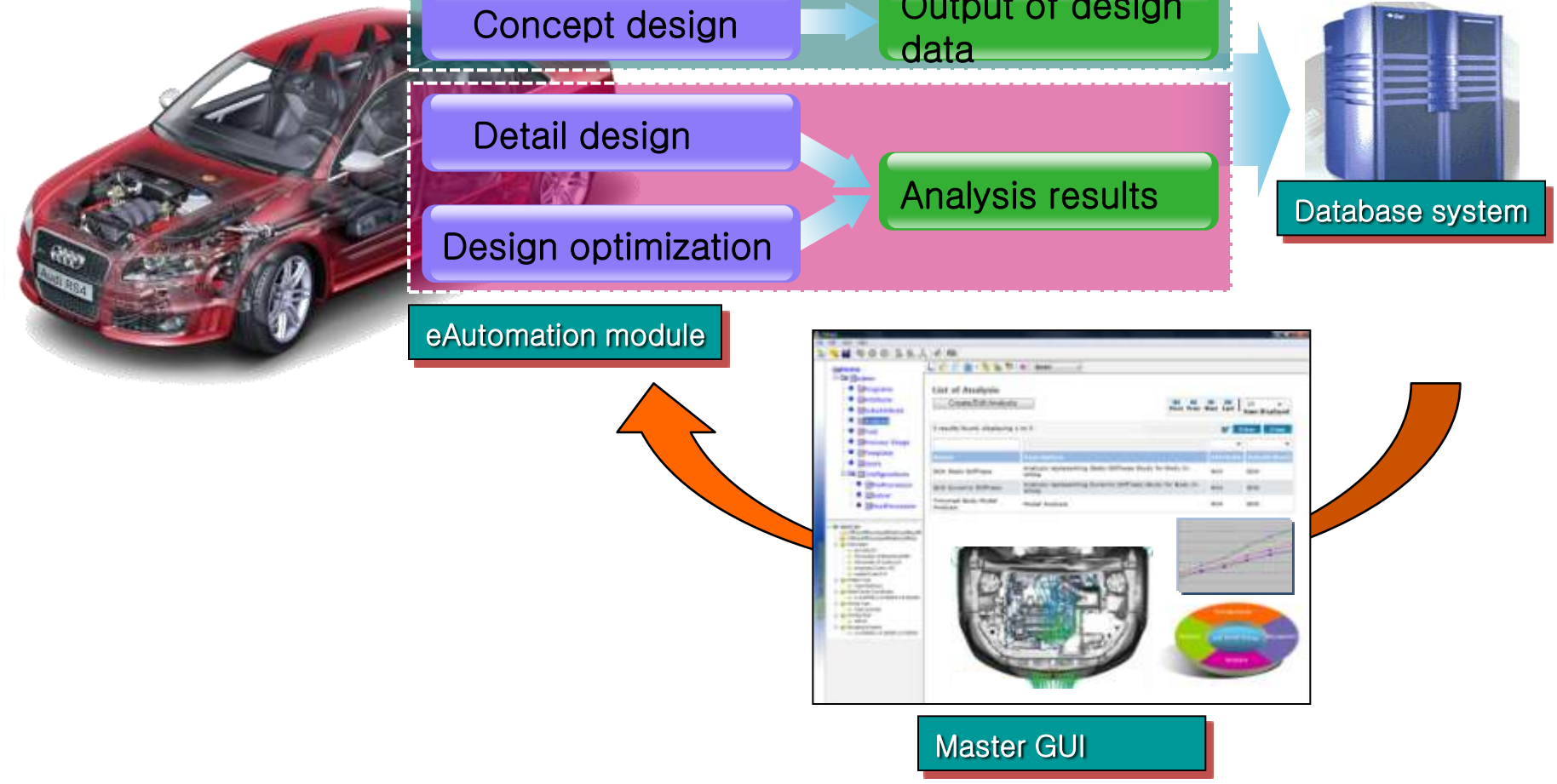
6. Automated Analysis System

Architecture of Automation + Database



6. Automated Analysis System

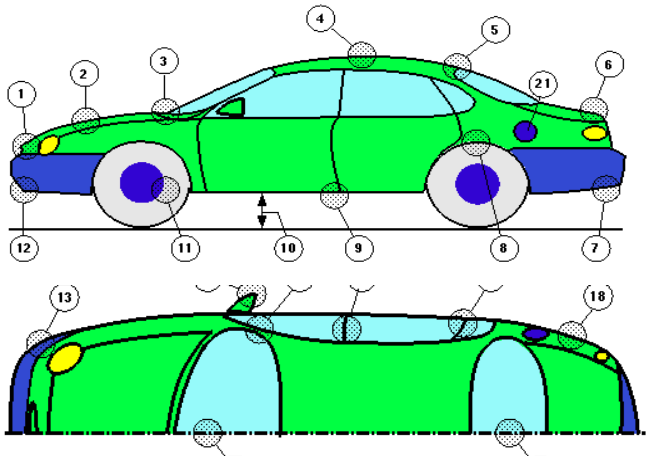
DDD (Data Driven Design)



6. Automated Analysis System

- Data Driven Design
  - Making a Database with previous + New data (requires HPC for many CFD calculation)
  - Data mining method : using Genetic Algorithm

Design parameter

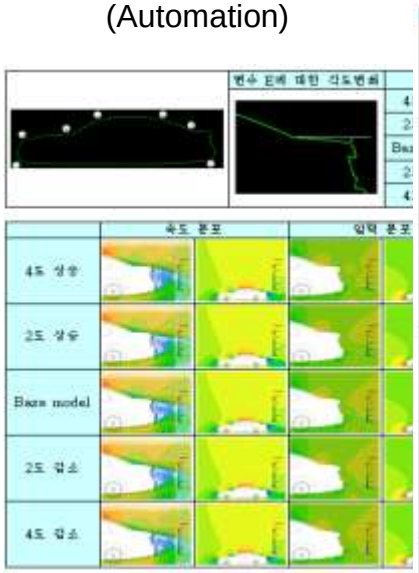


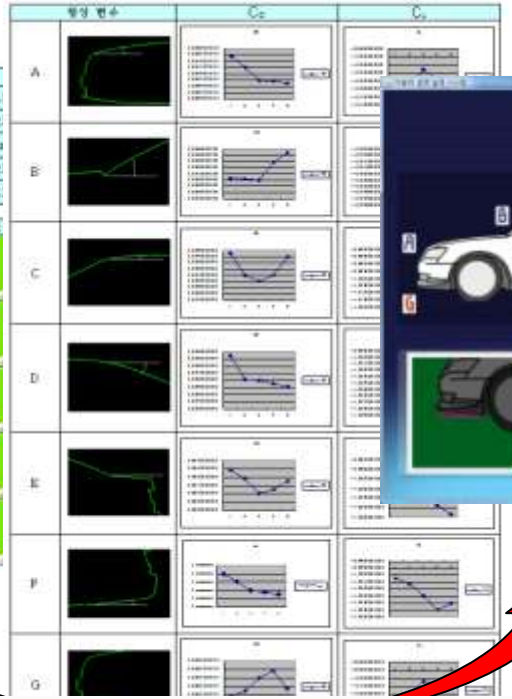
CONTENTS

1. FRONT END	8. WHEEL WELL COVER	15. A-PILLAR
2. HOOD	9. UNDERBODY	16. B-PILLAR
3. COWL	10. RIDE HEIGHT	17. C-PILLAR
4. ROOF	11. WHEELS/TIRES	18. QUARTER PANEL
5. BACKLITE HEADER	12. AIR DAM	19. BACKLITE ANGLE
6. DECKLID	13. BUMPER WRAP	20. WINDSHIELD
7. U/B DIFFUSER	14. SIDE MIRRORS	21. FUEL ECONOMY

Analysis and Measured data

(Automation)



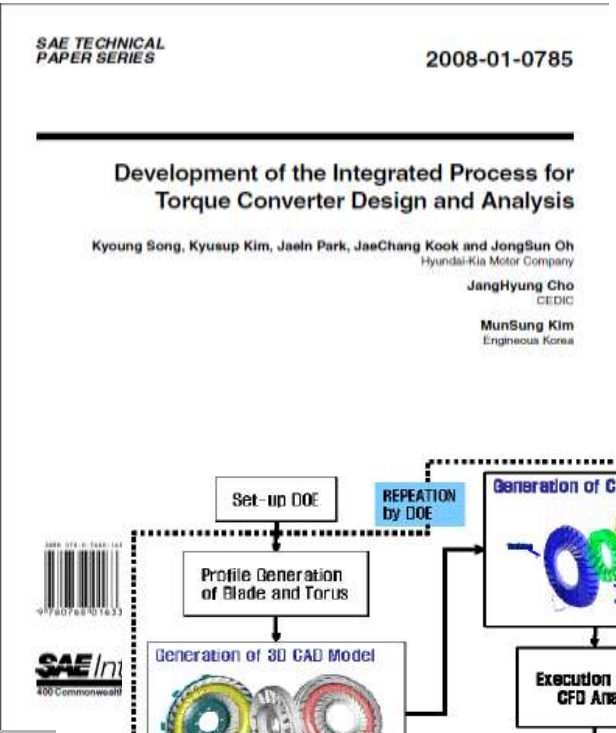


E-Predict

Update every year with new data

6. Automated Analysis System

The optimized design & analysis system of Torque converter (TDOS, 2006)


SAE TECHNICAL PAPER SERIES

2008-01-0785

Development of the Integrated Process for Torque Converter Design and Analysis

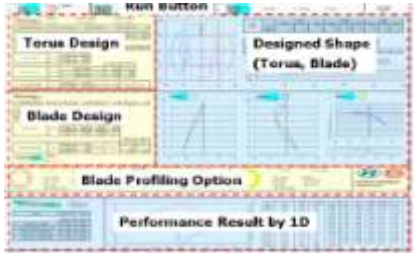
Kyoung Song, Kyusup Kim, Jaeln Park, JaeChang Kook and JongSun Oh
Hyundai-Kia Motor Company

JangHyung Cho
CEDIC

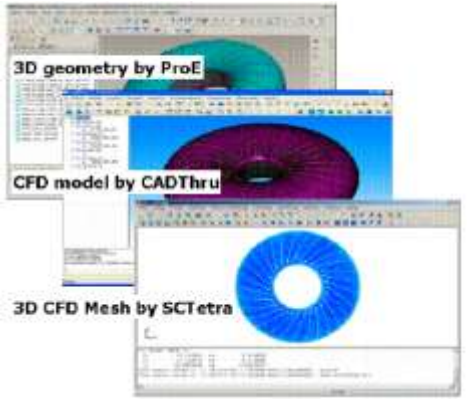
MunSung Kim
Engineous Korea

Workflow of TDOS

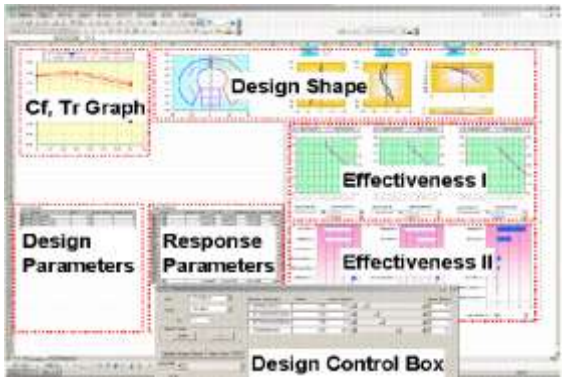
DOE Setup



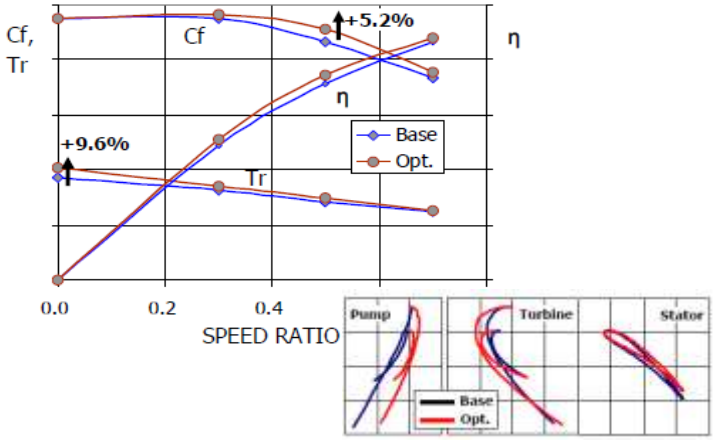
BPG for blade profile



Modeling process



Report of TDOS



Optimized results

6. Automated Analysis System

Web based fan design and analysis system – Automation

Client

Step 1

Select whether CAD modeling or not

Input design parameter for CAD modeling

Select CAD file of previous models

Set pre-processing option

Set solving option

6. Automated Analysis System

Web based fan design and analysis system - Automation

Thank You !