

Various CFD applications in the automotive design



2004

CD-adapco Korea



www.cdak.co.kr

OUTLINE

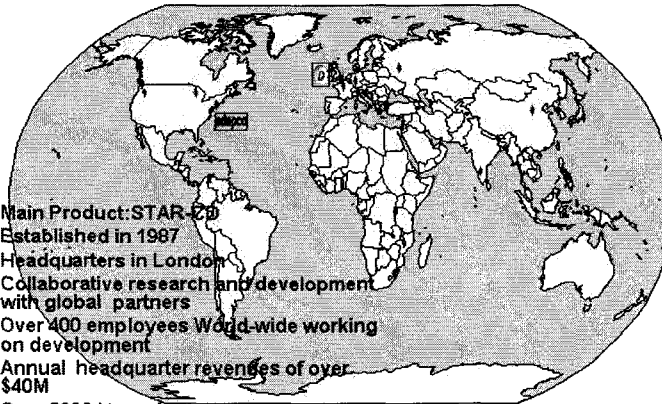
1. Who is CD-adapco Group ?
2. Various CFD applications
 - Exterior Aerodynamics
 - Wiper List CFD Simulation
 - Aeroacoustics
 - HVAC System
 - Front End Cooling
 - Intake/Exhaust
 - Engine Performance Simulation by GT-POWER
 - In-cylinder Engine Simulation
 - Engine Cooling Simulation
 - Fluid-Structure Interaction
 - Brake Cooling Simulation
 - Fuel Pump/Oil Pump/Torque Converter
 - Fuel Cell





- 1. Web to CAD/CAE
- 2. CFD application
- Acoustic noise
- RMC system
- Flow Life of Cooling
- Submergence
- CF-POWER
- In-cylinder Engine
- Engine Cooling
- PIV
- Water Cooling
- Flow/CFD Power
- Fluid Cell

Global partnership of CD adapco Group



- Main Product: STAR-CD
- Established in 1987
- Headquarters in London
- Collaborative research and development with global partners
- Over 400 employees World-wide working on development
- Annual headquarter revenues of over \$40M
- Over 3000 Users World-wide



3

A CROSS SECTION OF STAR-CD's INDUSTRIAL USERS

- 1. Web to CAD/CAE
- 2. CFD application
- Acoustic noise
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- Flow Life of Cooling
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- CF-POWER
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- | | | |
|---------------------|--------------------|-------------------|
| • ABB | • Ford | • Nissan |
| • Alfa Laval | • Fuji | • Ove Arup |
| • ABB Alstom | • General Electric | • Pratt & Whitney |
| • Astra Draco | • General Motors | • Renault |
| • Audi | • Hitachi | • SAAB |
| • BMW | • Honda | • SNCF |
| • British Aerospace | • ICI | • Sony |
| • Daimler Chrysler | • Lucas Aerospace | • Sulzer |
| • CERN | • Matsushita | • Toyota |
| • Ferrari | • McLaren | • Toshiba |
| • Fiat | • Mitsubishi | • Unilever |
| | • National Power | • Volvo |

Automotive Customers in Korea

- Hyundai-Kia(huge licenses), GMDAT, Ssangyong Motors
- Mobis, Delphi, Modine, Doowon, Samsung HVAC, MaleDonghyun,
- Dongwon, HAC, Kefico, Daekifaurecia, Samhyup, Jatco,
- KATECH, IAE, (More than 200 Users)

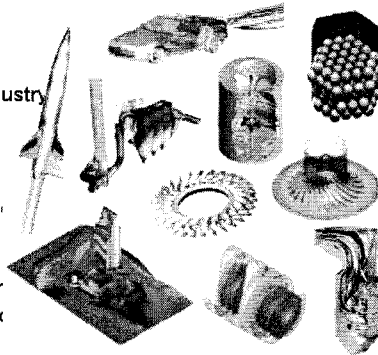


4

VARIOUS APPLICATIONS IN THE INDUSTRIES WITH STAR-CD

1. Who is STAR-CD?
 2. CFD applications
 Aerospace
 SPAC System
 Flow IES of Cooling
 Internal Flow
 GE-POWER
 In-cylinder Engine
 Engine Cooling
 FSI
 Heat Cooling
 FluidCF Power
 Fluid Cell

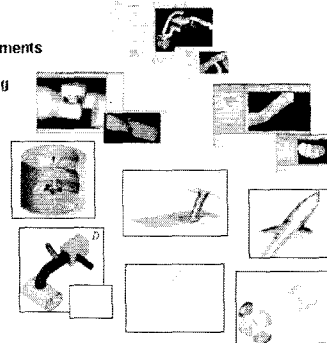
- Automotive
- Aerospace
- Turbomachinery
- Chemical and Process Industry
- Power Generation
- Heavy Industry
- Mechanical
- Building, Safety and Envir
- Electronics and Domestic Appliances
- Marine and Offshore Engin
- Bio Engineering and Medi
- Fuel Cell



STAR-CD IS DESIGNED WITH INDUSTRIAL USERS NEEDS IN MIND

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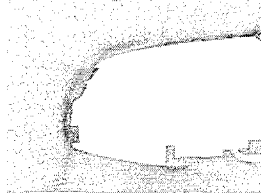
- Easy to learn and use interface
 - Process oriented GUI with guidance and navigation system
- Flexible CAD interface and automatic meshing
 - Alternative choices to suite different environments
- Extensive thermophysical & chemical modelling
 - From steady non-Newtonian to transient, transonic and reacting flows
- Complete mesh flexibility
 - Any cell shape or grid structure
- State of the art numerics for fast, robust, efficient, and accurate solutions
 - Accuracy at an affordable price
- Utilisation of advance computer technology
 - Code optimisation and parallel processing
- Advance analysis and post-processing tools
 - Innovative data processing and visualisation
- Technical support and know-how
 - Experienced and industry aware engineering support team



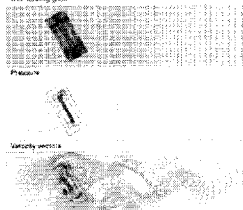
NEW RELEASE TECHNIQUE OF STAR-CD

- 1. Who is CD-CD?
- 2. CFD application
- Automotive
- WPC design
- Flow ESD-Cooling
- In-Sheet Simulation
- ES-PCWES
- In-cy Boiler Design
- Engine Cooling
- P&B
- Bottle Cooling
- Flue-Gas Flow
- Fluid Cell

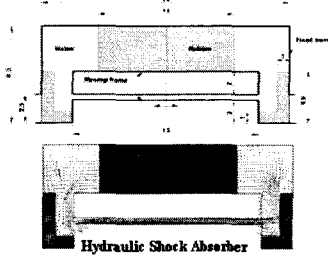
Polyhedral Mesh



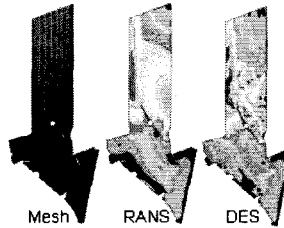
Overlapping Grids



Coupled simulation of flow and solid deformation



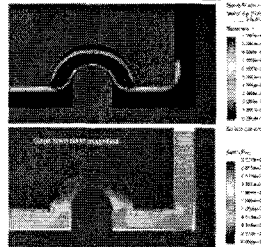
Detached-Eddy Simulation (DES)



NEW RELEASE TECHNIQUE OF STAR-CD

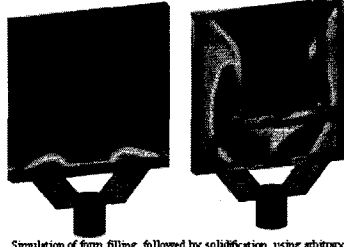
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Solidification and Melting



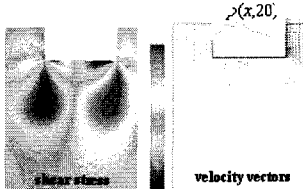
Solidification of liquid metal in a mold with natural convection in liquid part and deformation of the solidified part.

Casting

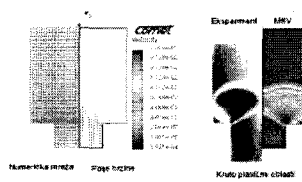


Simulation of form filling, followed by solidification, using arbitrary polyhedral grid.

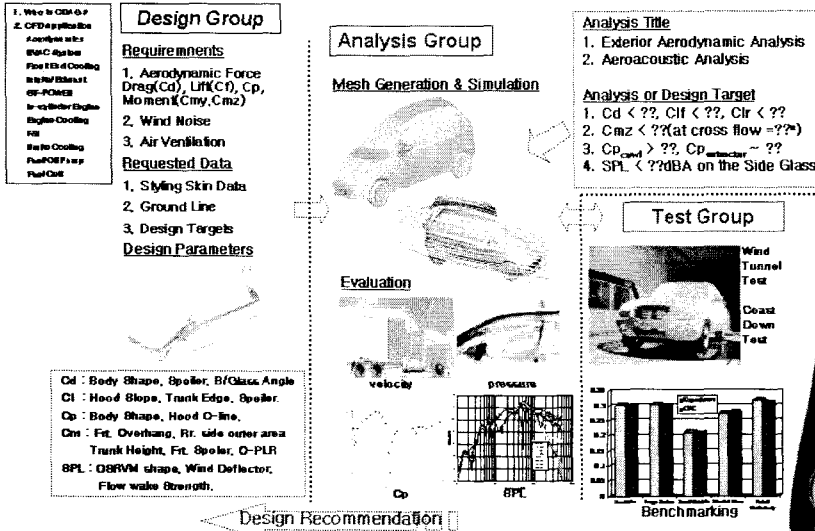
Cold Metal Forming



Led Extrusion



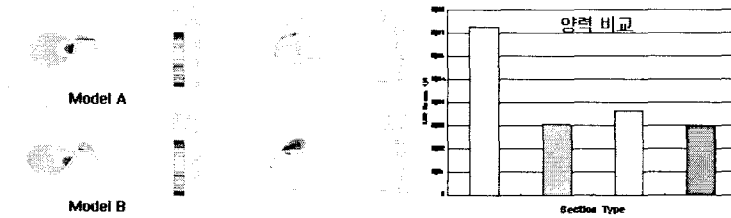
CFD APPLICATIONS - AERODYNAMICS



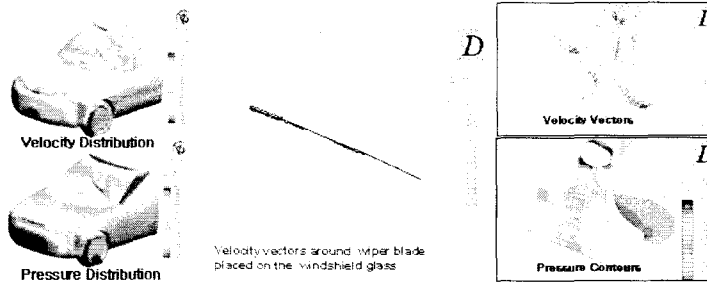
9

CFD APPLICATIONS – Wiper Lift CFD Simulation

(1) Aerodynamic performance on wiper frame typical section by 2-dimensional CFD simulation



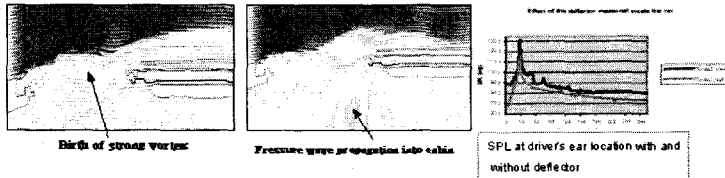
(2) Aerodynamic performance on wiper system on the windshield by 3-dimensional CFD simulation



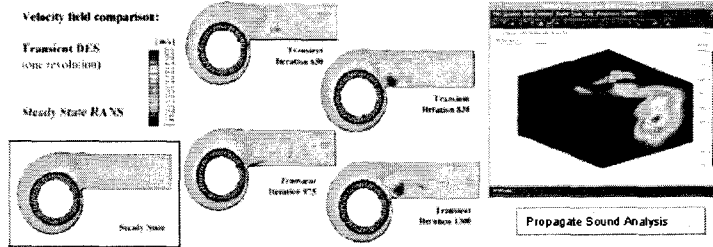
10

CFD APPLICATIONS – Aeroacoustics

(1) Sun roof buffeting Noise

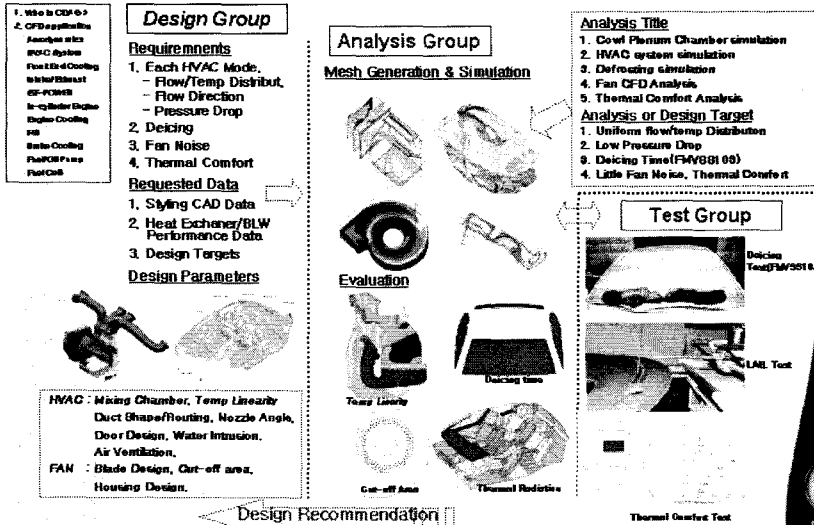


(2) HVAC Blower Fan Noise simulation



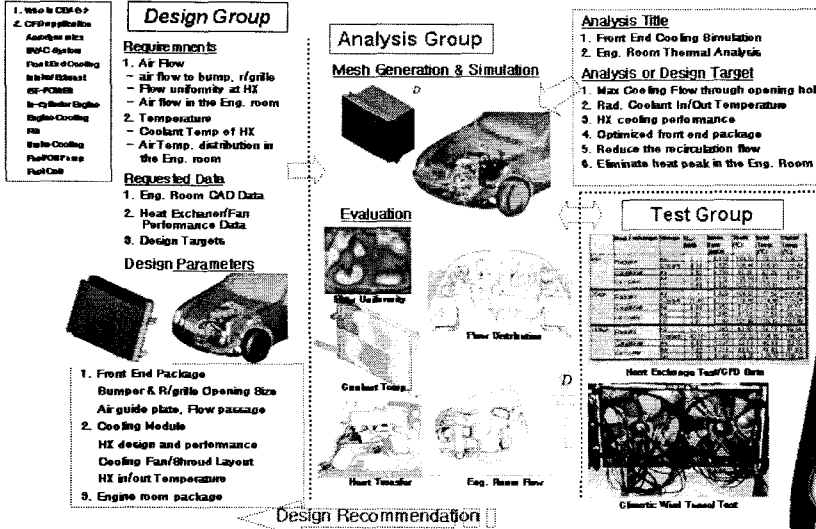
11

CFD APPLICATIONS - HVAC SYSTEM SIMULATION



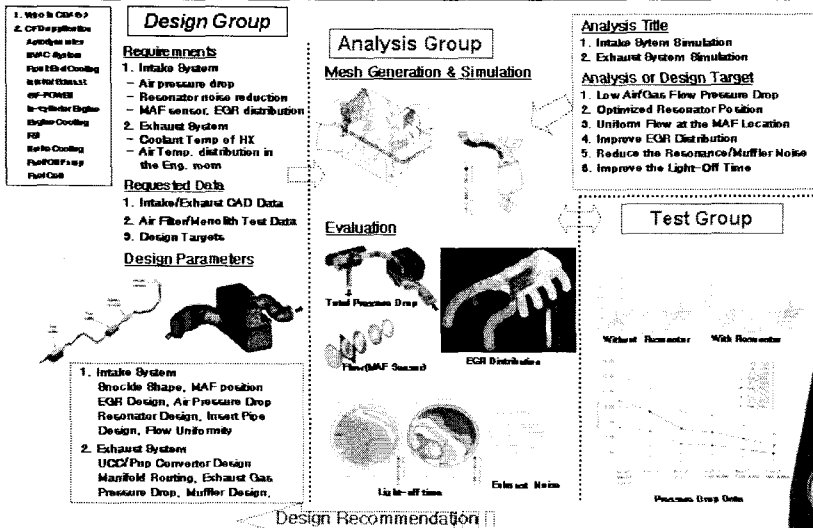
12

CFD APPLICATIONS - FRONT END COOLING SIMULATION



13

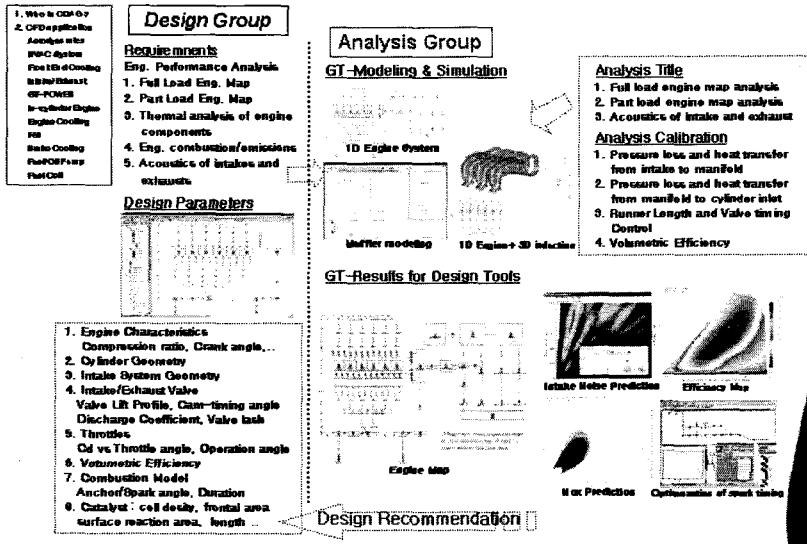
CFD APPLICATIONS - INTAKE/EXHAUST SIMULATION



14

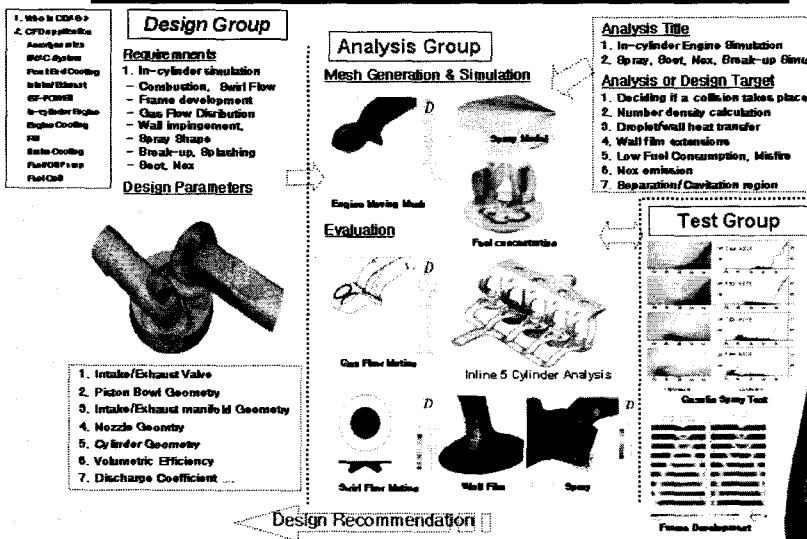


CFD APPLICATIONS - Engine Performance Simulation by GT-POWER



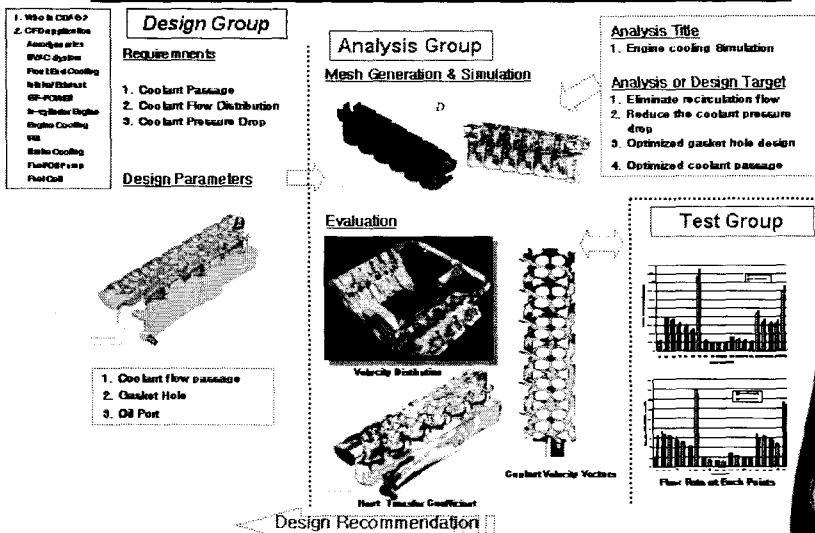
15

CFD APPLICATIONS - IN-CYLINDER ENGINE SIMULATION



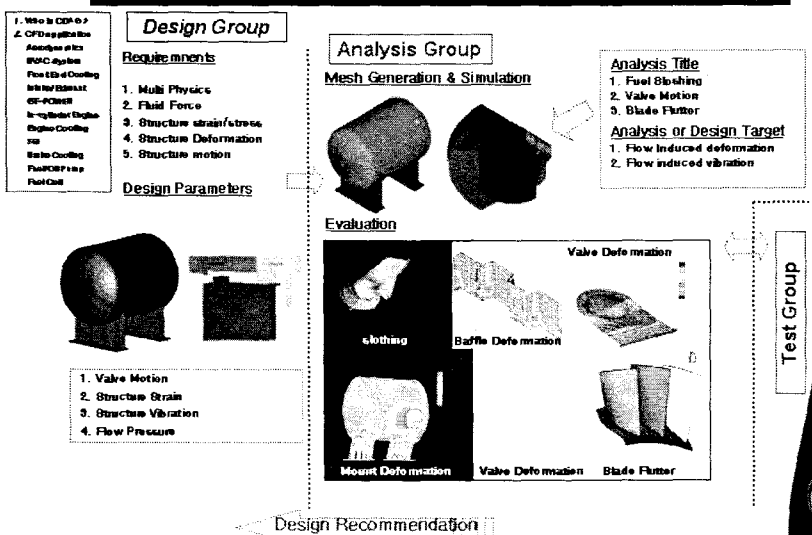
16

CFD APPLICATIONS - ENGINE COOLING SIMULATION



17

CFD APPLICATIONS - FLUID-SOLID INTERACTION



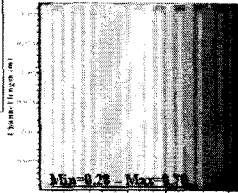
18

CFD APPLICATIONS – Fuel Cell

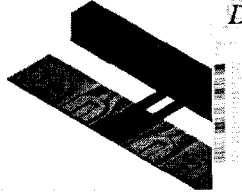
- 1. Who is CFD?
- 2. CFD applications
- Automotive
- MEMS
- Power Electronics
- Microfluidics
- CFD POWER
- In-cylinder Engine
- Engine Cooling
- RAM
- Heat Exchanger
- Power Plants
- Fluid Cells

Local Current density (A/cm²)

Very high inlet Humidity : T_{inlet}=95/98°C



Pressure Sistribution



High inlet Humidity : T_{inlet}=85/75°C

Oxygen mole fraction

cathode liquid water mass fraction

