




SC/Tetra를 이용한 유체기계의 성능, 유동 및 소음 해석

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 Korea

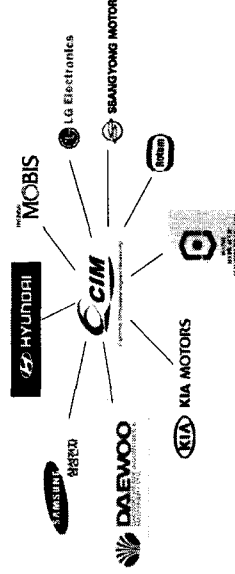




ECIM 주식회사



회사소개

- 열유체 및 유동소음 관련된 solution을 제공하고 기술 개발
- SC/Tetra, HearPAC, STREAM, LH3D를 판매하며 FlowNoise, S/W를 개발함
- CFD, 유동소음 및 최적화와 저소음 설계에 관한 기술응용 수행

주요고객사 : Hyundai Motors, Ssangyong Motors, KIA Motors
 Hyundai Mobis, SAMSUNG Electronics, LG Electronics, etc.



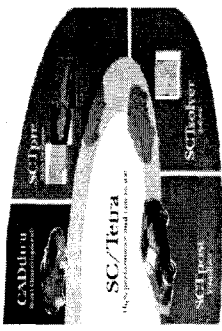
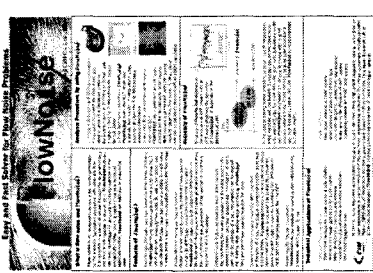
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SC/Tetra & FlowNoise

- SC/Tetra
Simple, Easy & Fast CFD Solver
- FlowNoise
Simple, Easy & Fast Aeroacoustic Solver

Innovative CFD-ware

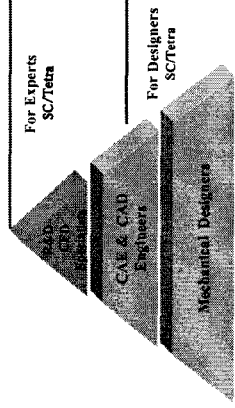



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SC/Tetra V 5.0 특징

The *CFD tool* for designer



Must be simple, fast, and low cost.

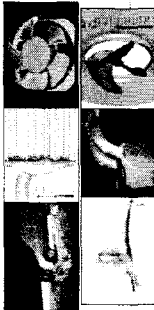
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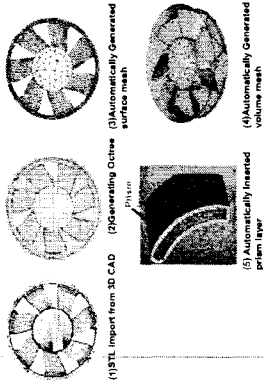
SC/Tetra V 5.0 특징

- 설계자를 위한 지능형 3차원 CFD 통합 패키지
- SC/Tetra Pre : Octree를 이용한 자동 격자 생성 (Surface mesh에서 Prism 까지)
CADTool를 이용한 direct CAD import, Easy CAD repair
- 빠르고 강력한 CFD Solver
 - Node based FVM CFD Tool (250만개 격자 사용시 P-IV 1.8GHz로 8시간 소요)
 - 최신 matrix solver: AMG / MICCG-STAB method
 - 해은 unsteady (sliding mesh) 해석
 - 9개의 난류모델 : Standard k- ϵ , RNG k- ϵ , MP k- ϵ , Linear low Reynolds number k- ϵ (AKN), Realizable k- ϵ , Linear low Reynolds number k- ϵ (GPC), Non linear low Reynolds number k- ϵ , SST k- ω model
 - 고체 유체 물 복사 연속 해석
 - Multi-component (multi-species) flows
 - 운동 확산 해석
 - Free surface
 - PMV 해석
 - 수도 해석



SC/Tetra V 5.0 특징

Automotive mesh generating : SC/Tetra Pre
User는 Octree 작업만 수행, surface, volume, prism 격자까지 자동 생성
강력한 Adaptive 격자 생성 능력



Scene-Automatic Mesh Generator
It generates a computational mesh almost automatically.

You only need to specify granularity and believe in their power.

Adaptive mesh refinement system is prepared for automatic all wall treatment. All wall need to input the number of elements.

The generated mesh has been optimized and optimized again for the most suitable generative high speed.



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SC/Tetra V 5.0 특징

SC/Tetra Solver
Wizard를 이용한 빠르고 간단한 해석조건 입력
일본 JSAT 학회 주관 CFD Solver benchmark test에서 우승 차지 (2001)

High Performance Solver
High performance with small increase requirement
Award winning code is benchmark test by JSAT

Case	Nodes	Elements	Time (min)	Time (sec)
1	1,000,000	1,000,000	12.0	720.0
2	2,000,000	2,000,000	24.0	1440.0
3	4,000,000	4,000,000	48.0	2880.0
4	8,000,000	8,000,000	96.0	5760.0
5	16,000,000	16,000,000	192.0	11520.0
6	32,000,000	32,000,000	384.0	23040.0
7	64,000,000	64,000,000	768.0	46080.0
8	128,000,000	128,000,000	1536.0	92160.0
9	256,000,000	256,000,000	3072.0	184320.0
10	512,000,000	512,000,000	6144.0	368640.0

Geberex FVM (Various size) Awarded in 2001



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Sirocco Fan of HVAC System

HVAC System of a car with Sirocco Fan
Divide the HVAC system into the fan part and duct part

Shape of the sirocco fan
Inlet diameter : 121mm, outlet diameter : 142mm
Inlet angle : 52.6°, outlet angle : 47.7°
3.47million elements and 0.82million nodes
Rotating velocity : 2793 RPM, flow rate : 220 CMM

Computational domain of HVAC system

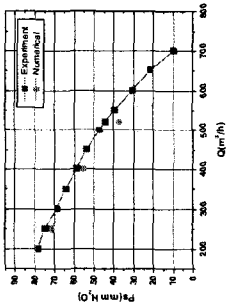


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Sirocco Fan of HVAC System

- Performance of the sirocco fan
Flow condition : 2793 rpm, $d_t = 4.475 \times 10^{-5}$ sec
Standard k-e turbulent model



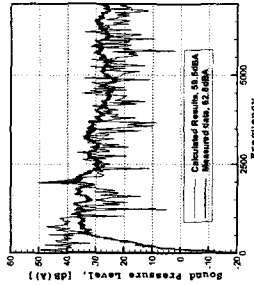
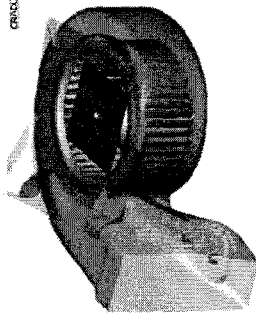
Analyzed unsteady flow field of the sirocco fan

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Sirocco Fan of HVAC System

- Sirocco fan of HVAC system
- Predicted acoustic pressure at far field



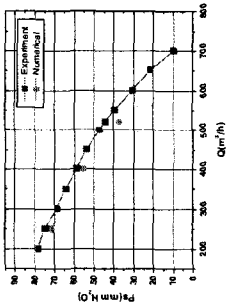
Comparison between the calculated acoustic pressure with the measured one

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Sirocco Fan of HVAC System

- Performance of the sirocco fan
Flow condition : 2793 rpm, $d_t = 4.475 \times 10^{-5}$ sec
Standard k-e turbulent model



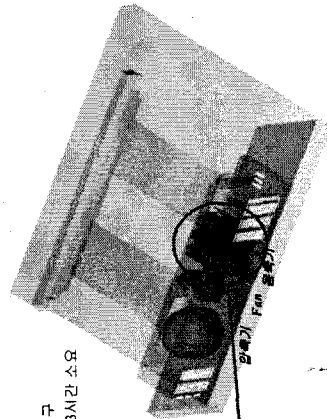
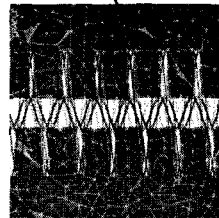
Analyzed unsteady flow field of the sirocco fan

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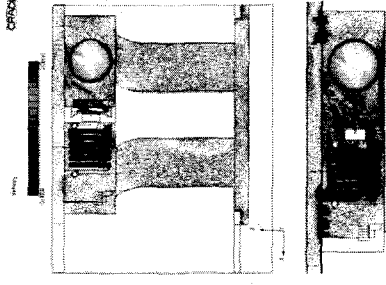
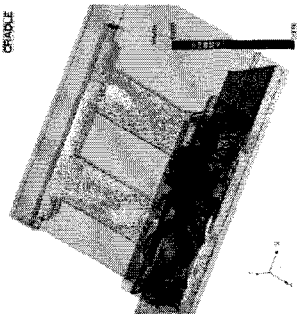
Machine Room of Refrigerator

- 냉장고 기계실 해석
- 냉장고 기계실내 응축기의 모델링이 문제
- 응축기 : 6단 6열, 열원
- 추위팬 : 1100rpm 직동
- 14*4 개의 흡입구와 14*2 개의 출구
- 600만 개 격자 사용, 각자 정점이 3시간 소요
- 응축기 판 사이에 prism 포함



Machine Room of Refrigerator

- 냉장고 기계실 해석
- 기계실 전체적인 유동 패턴을 확인 가능
- 응축기와 격자의 냉각 여부 확인 가능
- 입구와 출구 구멍의 크기와 위치 선정 가능



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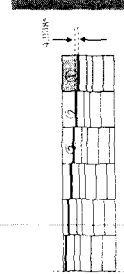
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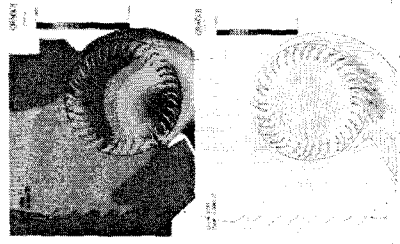


Air-conditioner with Cross-flow Fan

- CFD analysis
 - 35 Uneven pitched Impeller and 7 Inlet Guide vane
 - 165718 cells, 60000 cells for rotating impeller
 - Use fast CFD solver : SC/Tetra
 - Sectional model : span-wise length is 2cm
 - RNG k-ε Turbulent model
 - 2 days for 5000 time step (s+t)
 - dt = 1.349 × 10⁻⁴



Eccentric vortex



Pressure and velocity vector plot

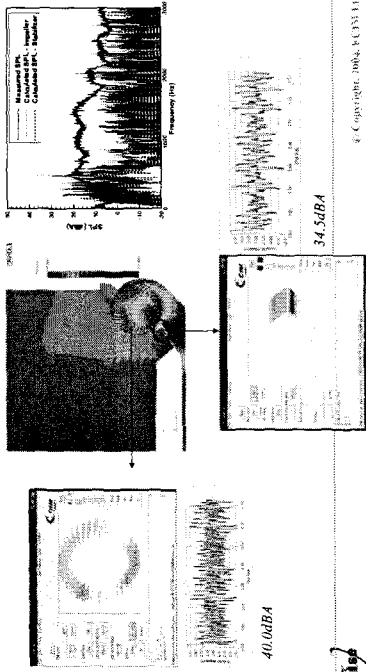


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Air-conditioner with Cross-flow Fan

- Aeroacoustic analysis by using FlowNoise
 - Noise generated from the rotating impeller and stationary stabilizer
 - Predicted SPL agrees well with the measured data



40.0MBA

34.5MBA

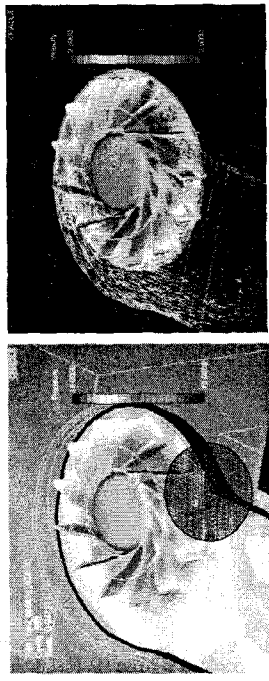


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Noise of Cooling Turbo Fan

- Unsteady flow field calculation using SC/Tetra
 - dt = 6.1583 × 10⁻⁵
 - Strong pressure fluctuation at the impeller tip and cut-off is shown.



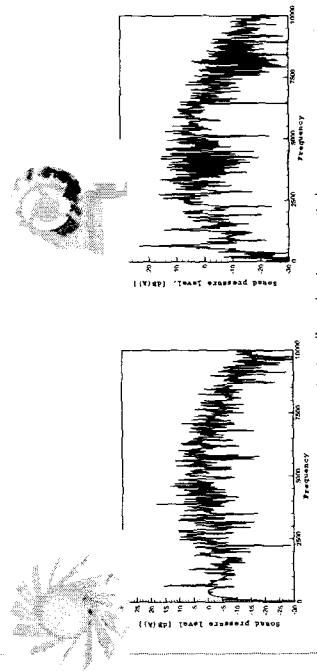
Fluctuation of surface pressure



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Noise of Cooling Turbo Fan

- Unsteady flow field calculation using SC/Tetra
 - Tone sound of BPF and 2nd BPF is dominant.



Predicted acoustic spectrum at given point, rotating impeller and casing, respectively



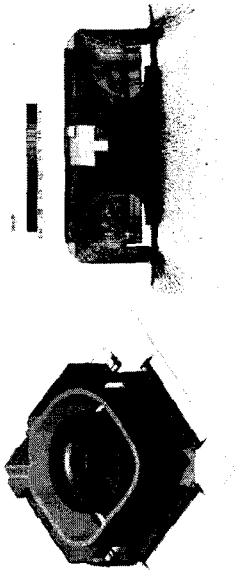
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System Aircon

Steady flow field calculation using SC/Tetra

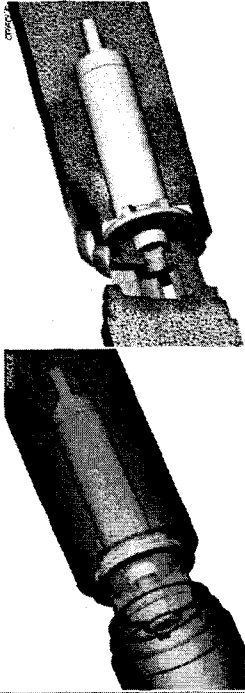
- Fan and heat exchanger model
- Calculated flow rate and fan pressure, velocity at heat exchanger



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Adaptive Meshing for Hydraulic Valve



- 격자 유체 : $\rho = 820.9\text{kg/m}^3$ Oil
- $\Delta P = 4.7$ Bar
- Adaptive mesh parameter

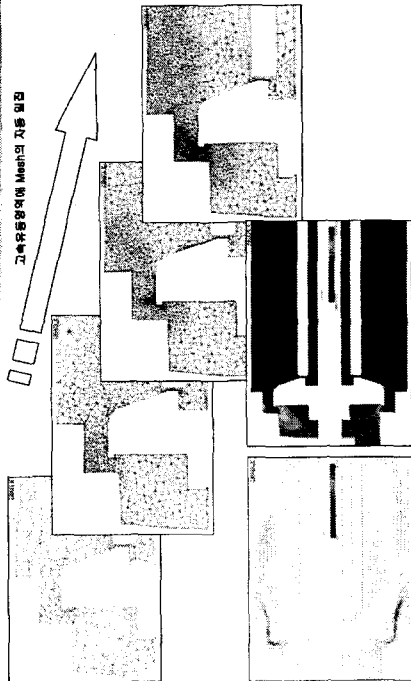
1. Number of Target mesh = 4,000,000%
2. Thickness of Pfilm Layer : $\gamma=5$
3. Number of Iteration for mesh adaptation = 7



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Adaptive Meshing for Hydraulic Valve



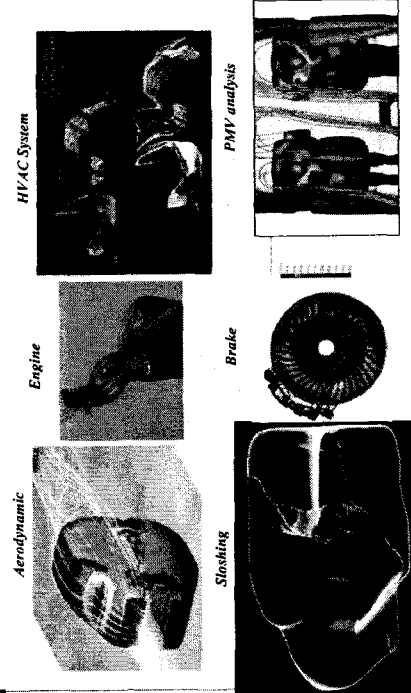
고속유동영역 Mesh의 자동 밀집



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Application to a car



Aerodynamic

Engine

HVAC System

Brake

PMV analysis

Steering

