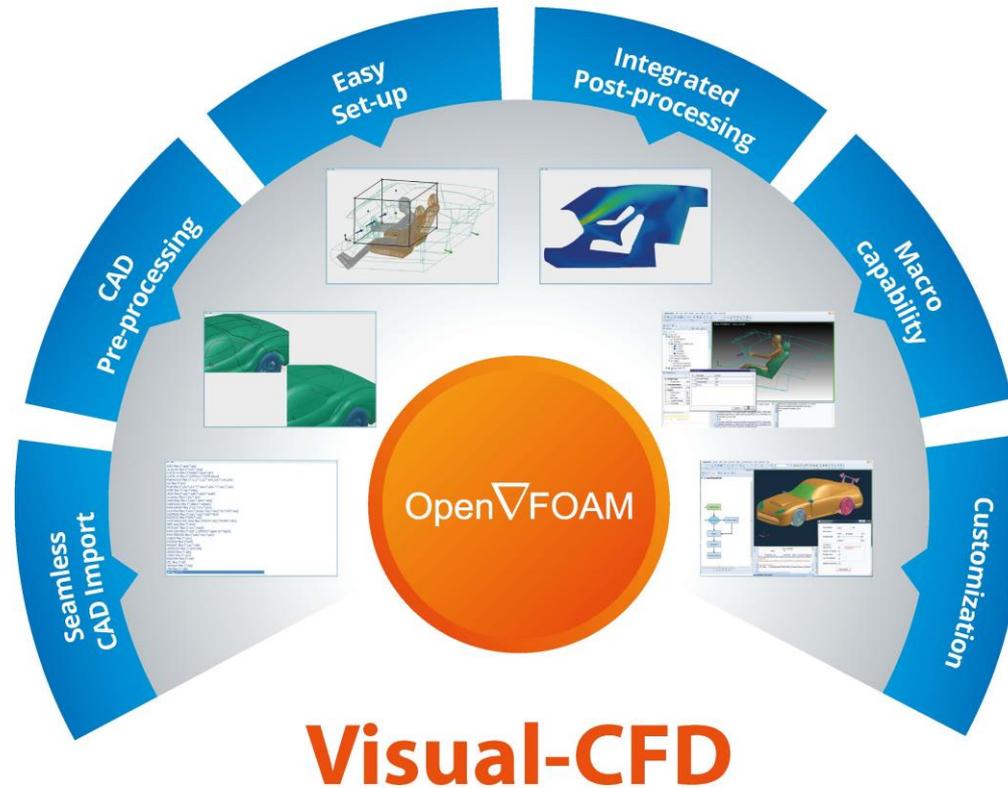


A Powerful GUI for OpenFOAM®

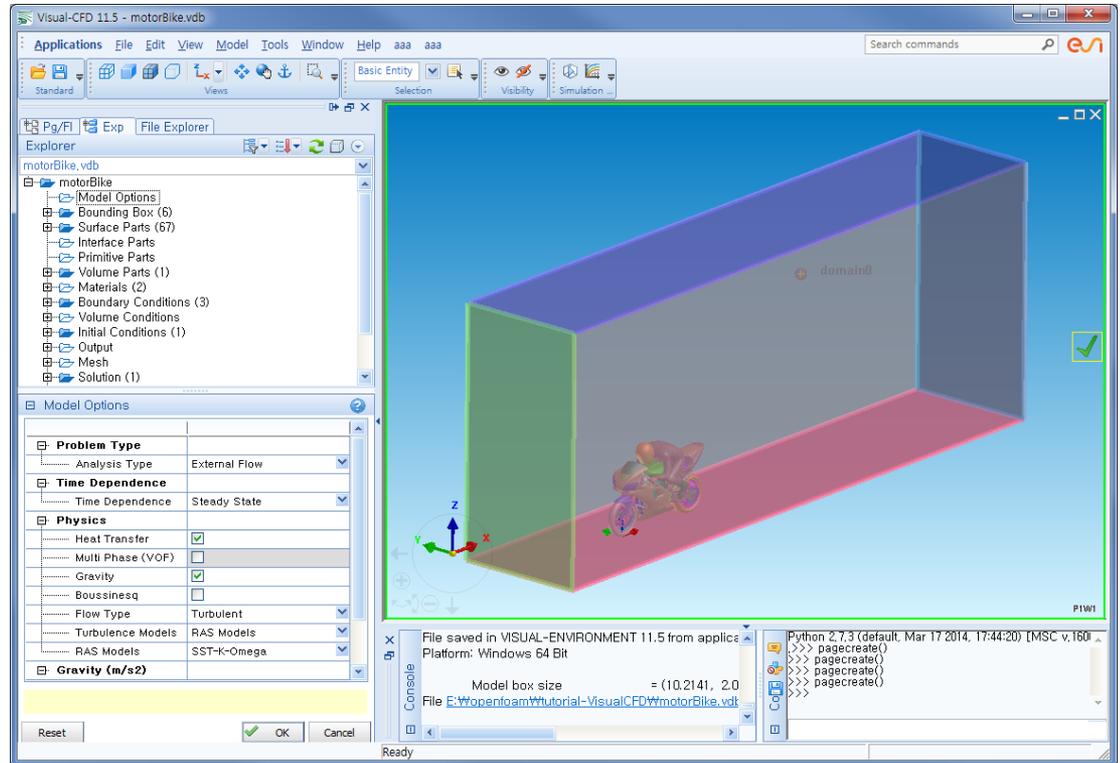


Contents

1. Visual-CFD 개요

2. Visual-CFD 주요 기능

- Model Options
- Bounding Box
- Surface Parts
- Volume Parts
- Material Properties
- BCs
- VCs
- ICs
- Output
- Volume Mesh
- Solver
- Numerical Scheme
- Simulation Control
- Save
- Run
- Macro
- User Customizing

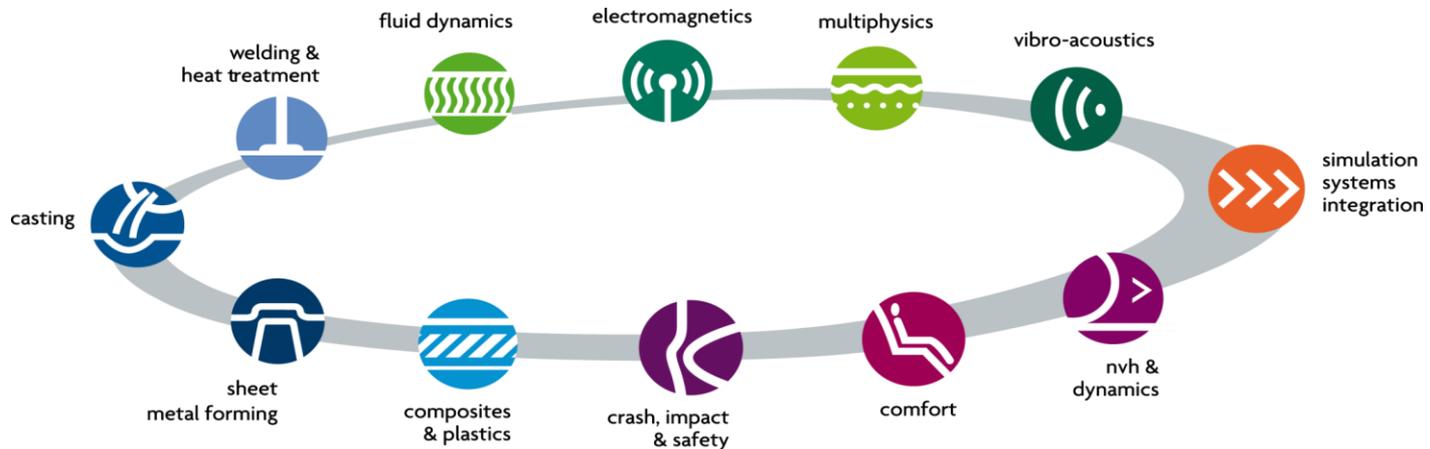


3. Visual-Process(SDK)

ESI Group 소개

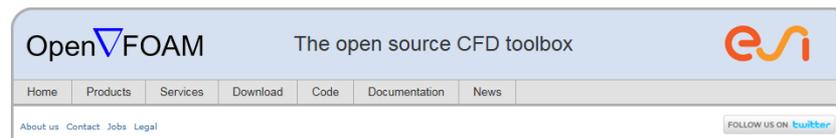
ESI Group

- 1973에 프랑스에서 설립되어 1985년 세계 최초로 자동차 충돌 해석 개발/수행
- 전 세계 50여개국 전 산업 분야의 Virtual Prototyping(CAE) 솔루션 제공



- 2012년 영국의 OpenFOAM 개발사인 OpenCFD Ltd 를 인수하여 ESI 그룹의 다양한 가상 해석 솔루션과 함께 OpenFOAM 솔루션을 개발/제공 중

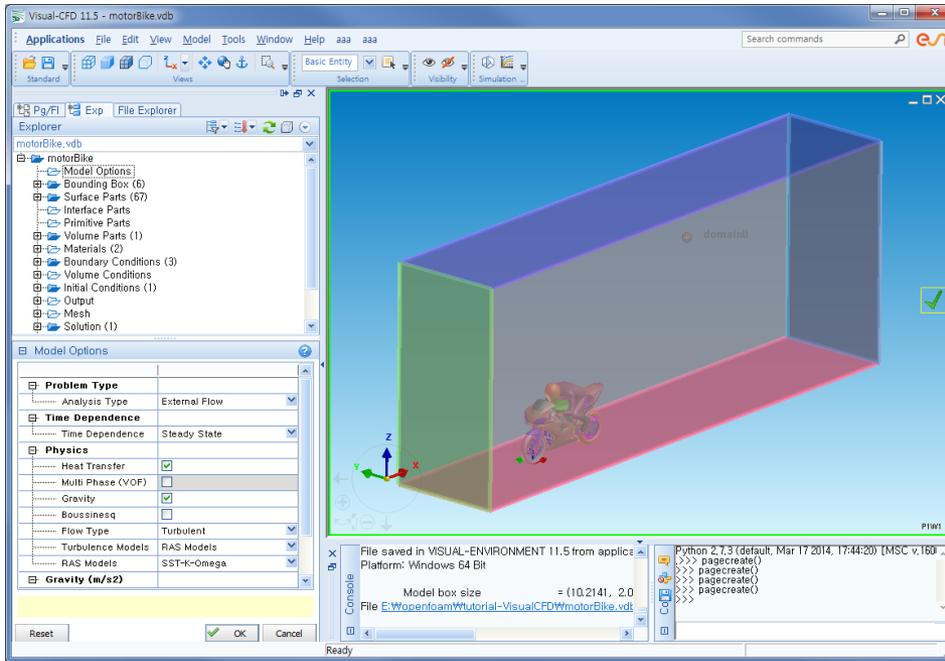
www.openfoam.com



1. Visual-CFD 개요

1. Visual-CFD 개요

ESI Group Software 통합 플랫폼 Visual Environment® 를 이용하여 개발한 OpenFOAM 사용자를 위한 인터페이스 (GUI)



- Visual-Environment 11.5
 - BatchTools Command Prom
 - Licensing Strategy 11.5
 - Readme Visual-Environment
 - Uninstall Visual-Environmen
 - Visual-Cast 11.5
 - Visual-CEM 11.5
 - Visual-CFD 11.5
 - Visual-Crash DYNA 11.5
 - Visual-Crash RAD 11.5
 - Visual-DIEMAKER 11.5
 - Visual-Environment 11.5
 - Visual-Environment BATCH
 - Visual-Life NASTRAN 11.5
 - Visual-Mesh 11.5
 - Visual-Quoting 11.5
 - Visual-RTM 11.5
 - Visual-Safe MAD 11.5
 - Visual-Seat 11.5
 - Visual-Systems 11.5
 - Visual-SYSTUS 11.5
 - Visual-Viewer 11.5
 - Visual-VTM 11.5
 - Visual-Weld 11.5
 - Documentation
 - Virtual Performance 11.5

OpenFOAM을 이용한 유동해석 전체 과정을
단일 GUI 환경에서 완전히 수행 가능

1. Visual-CFD 개요

- 개발 배경
 - ▶ 고객 맞춤형 GUI 개발 / 제공으로 노하우 축적
 - ▶ Visual-Environment 플랫폼 통합 (개발자/사용자 의견 반영)
 - ▶ OpenFOAM 진입장벽 해소 및 저변 확대

- 대상
 - ▶ OF 비전문가 : OF 지식 없이 사용 가능
 - ▶ OF Newbies : 진입 장벽 해소 및 빠른 적응
 - ▶ OF Experts : 현업 적용 효율성 증대

- 작동 환경
 - ▶ GUI : 윈도우 및 리눅스
 - ▶ 솔버 : Local / Docker / Remote (ssh)
 - 윈도우 : BlueCFD/Docker/VM/ Win10 Bash)
 - 리눅스 : As it is

LIST OF OpenFOAM® SOLVERS SUPPORTED

simpleFoam
 pimpleFoam
 rhoSimpleFoam
 rhoPimpleFoam
 buoyantSimpleFoam
 buoyantPimpleFoam
 buoyantBoussinesqSimpleFoam
 buoyantBoussinesqPimpleFoam
 interFoam
 multiphaseEulerFoam
 interDyMFoam
 pimpleDyMFoam
 rhoPimpleDyMFoam
 chtMultiRegionSimpleFoam
 chtMultiRegionFoam

OPERATING SYSTEMS

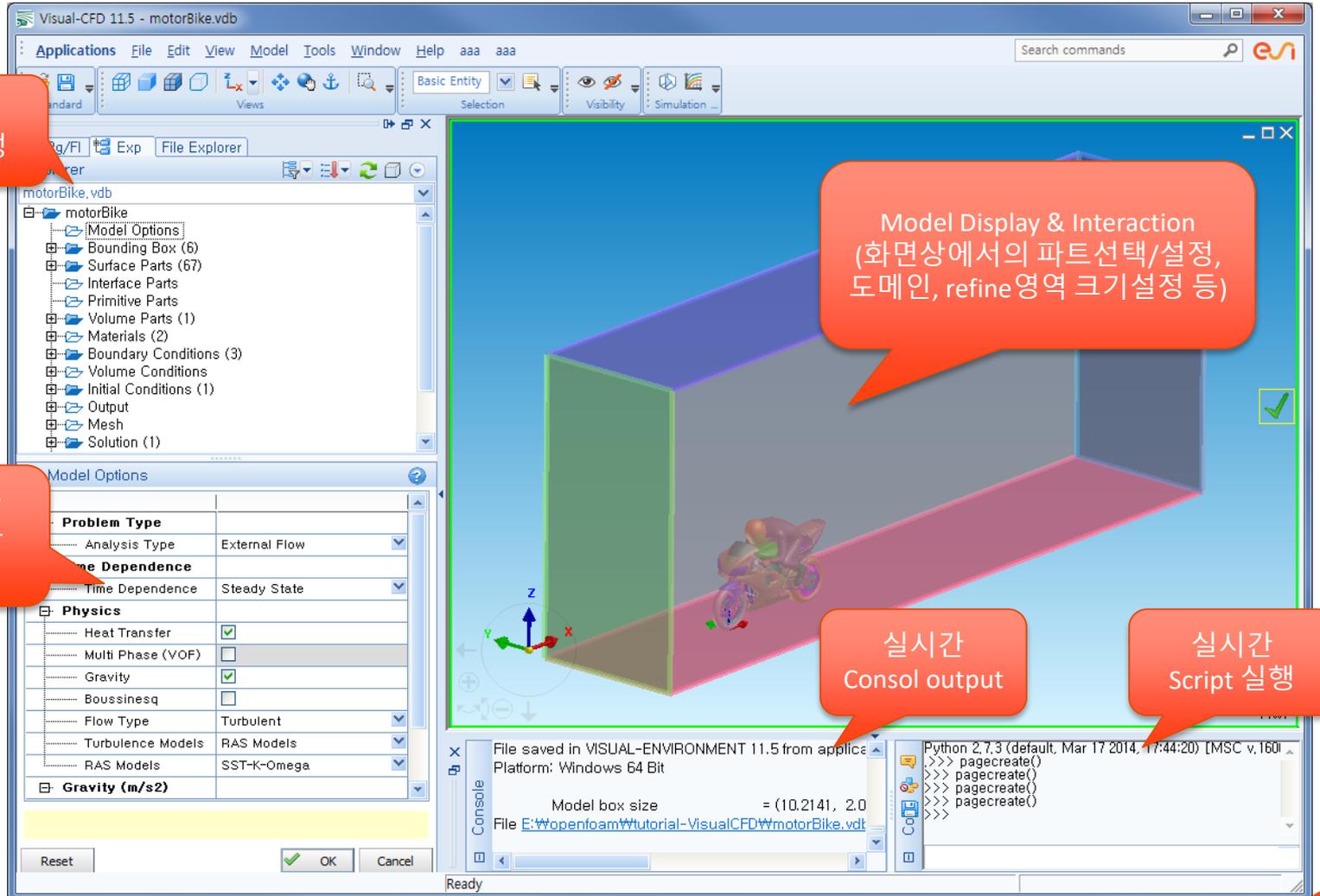
Linux 64 bit	RedHat	5, 6, 7.*
	CentOS	5, 6, 7.*
	SuSE	12.* until 42.1
	Ubuntu	12.04 until 17.04
	Fedora	20 until 25
Windows 64 bit	MS-Windows	XP, 2000, Vista, 7, 8, 8.1, 10

OpenFOAM® VERSION/FORMAT SUPPORT

OpenFOAM® Version	4.1 and 1612+
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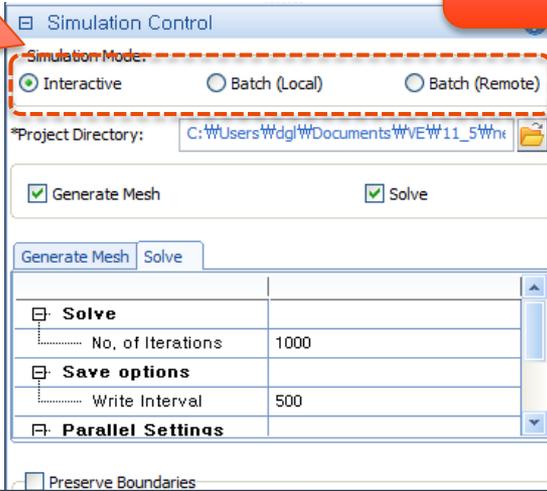
1. Visual-CFD 개요

기본 인터페이스

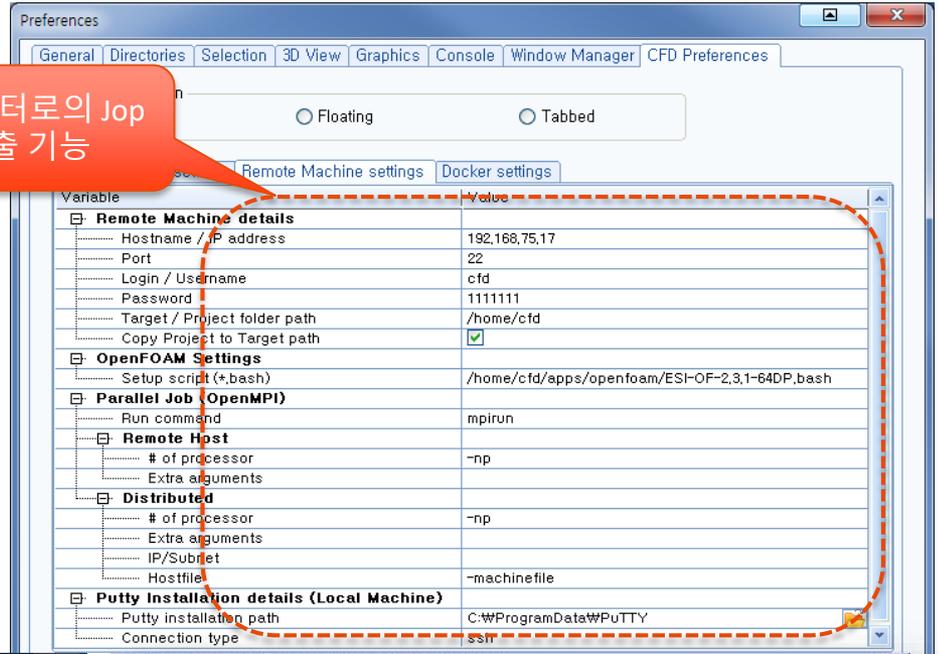


1. Visual-CFD 개요

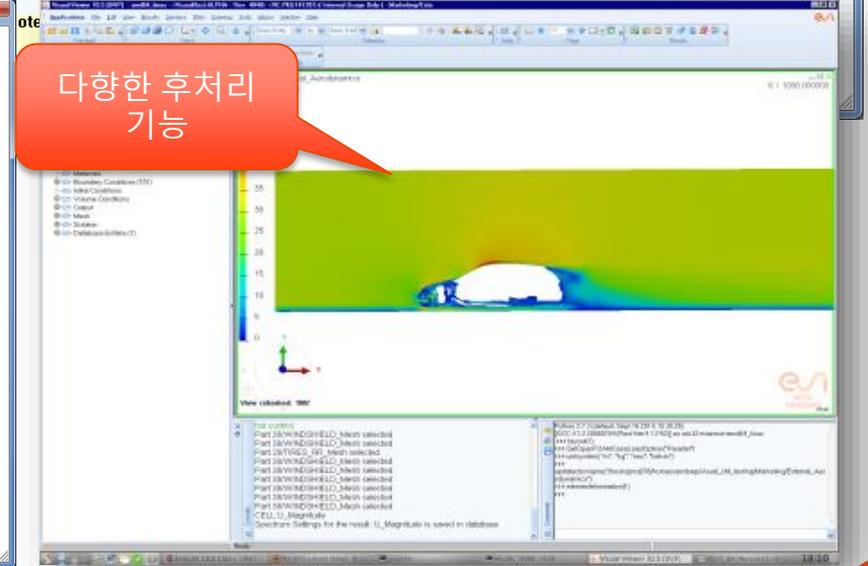
다양한 OpenFOAM
솔버 실행 방식



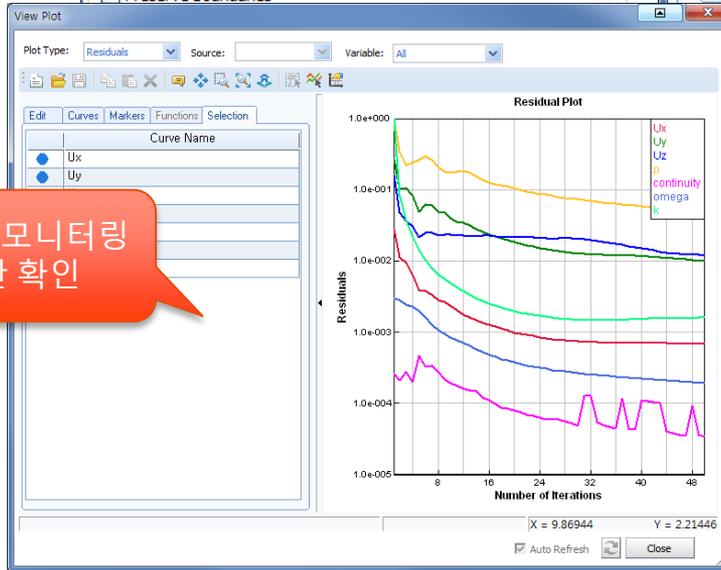
클러스터로의 Job
제출 기능



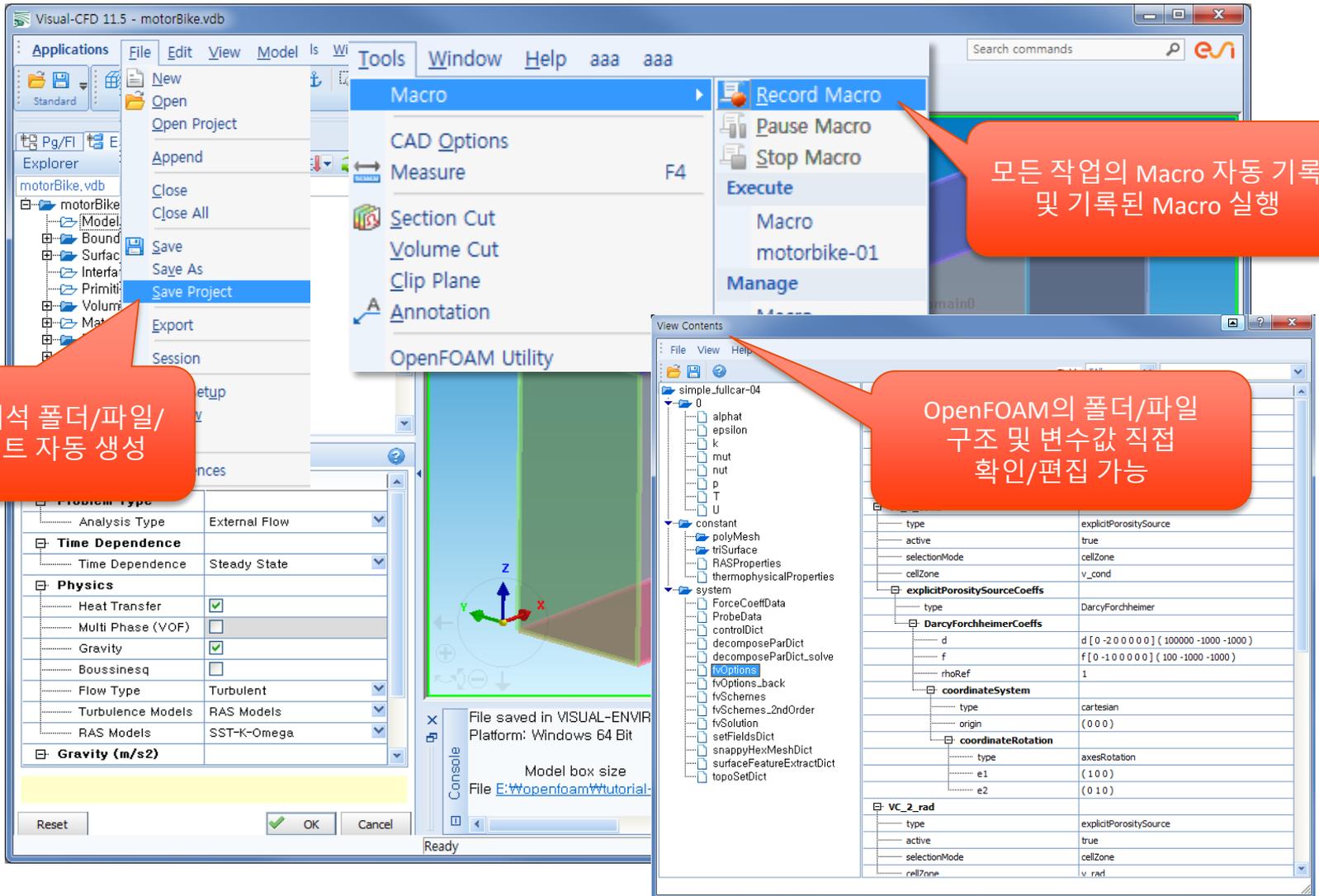
다양한 후처리
기능



수렴변수 및 모니터링
값 실시간 확인



1. Visual-CFD 개요



OpenFOAM 해석 폴더/파일/
실행 스크립트 자동 생성

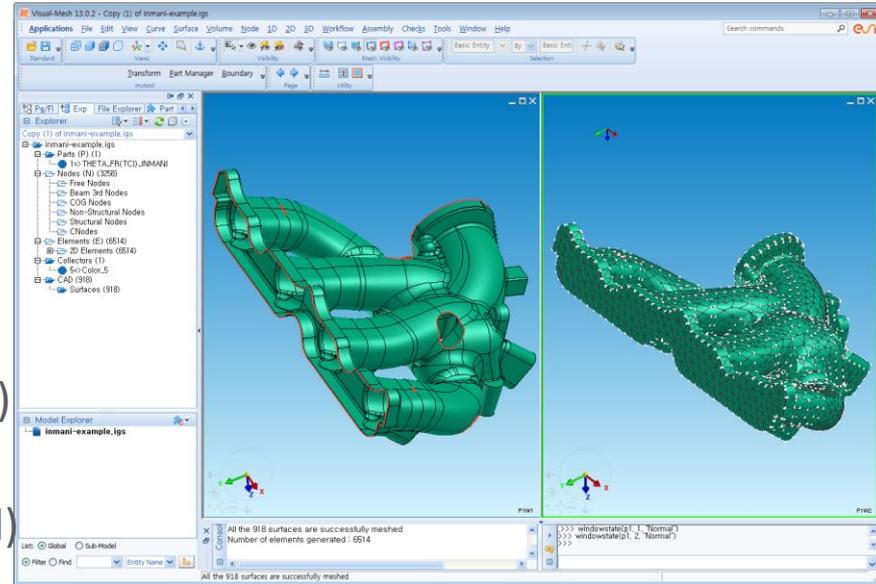
OpenFOAM의 폴더/파일
구조 및 변수값 직접
확인/편집 가능

1. Visual-CFD 개요

Visual-Mesh, Visual-Viewer

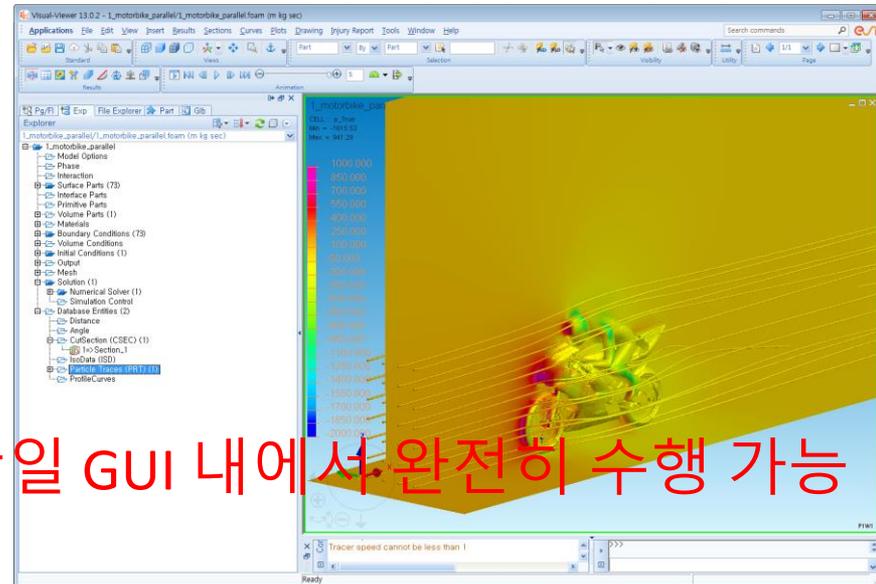
- **Visual-Mesh[®]**

- ▶ Geometry(점/선/면/솔리드) 작성/수정
- ▶ CAD Direct Import (IGES/STEP/CATIA/UG등)
- ▶ 형상 자동수정 / 표면격자 자동 생성
- ▶ 체적 격자 작성 (Hex, Tetra, Prism, Pyramid)



- **Visual-Viewer[®]**

- ▶ OpenFOAM 결과 후처리
- ▶ Section/Iso Surface/Stream line
- ▶ Steady/Transient Animation
- ▶ Visual-CFD 와 다양한 연계 기능



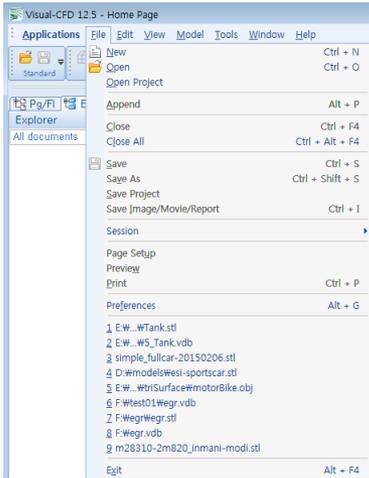
OpenFOAM 유동해석 전체 과정을 단일 GUI 내에서 완전히 수행 가능

2. Visual-CFD 주요 기능

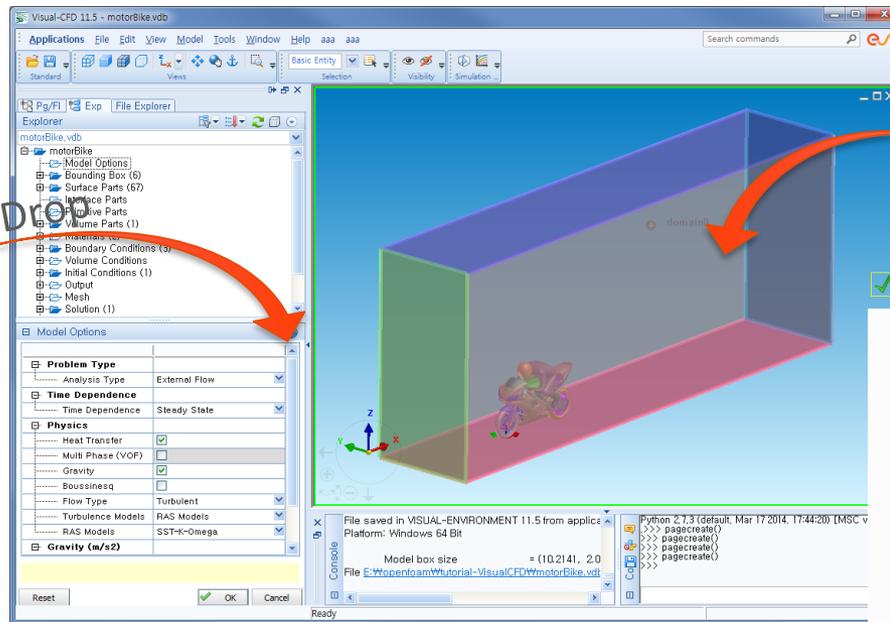
2. Visual-CFD 주요 기능

Model Open

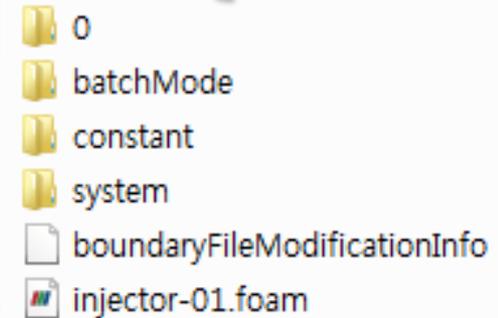
- 격자 모델 (STL, NAS, OBJ) Open/Import (드래그&드랍)
- 기존 OpenFOAM case Import (File – Open Project)
- Visual-CFD 자체 file format : *.VDB (모든 설정 및 geometry 저장)



Drag & Drop

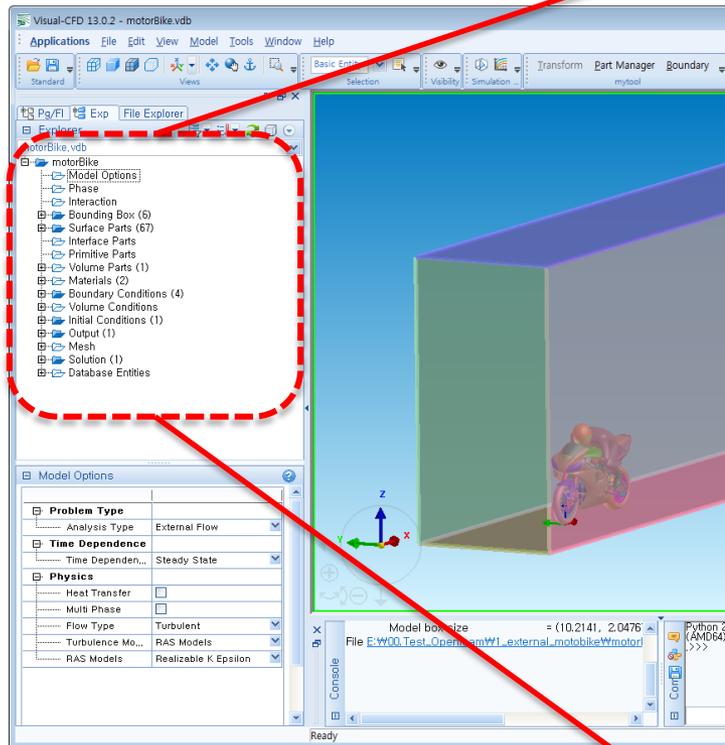


OpenFOAM Directory
Import



2. Visual-CFD 주요 기능

Model Setup Tree



- motorBike
 - Model Options
 - Phase
 - Interaction
 - ⊕ Bounding Box (6)
 - ⊕ Surface Parts (67)
 - Interface Parts
 - Primitive Parts
 - ⊕ Volume Parts (1)
 - ⊕ Materials (2)
 - ⊕ Boundary Conditions (4)
 - ⊕ Volume Conditions
 - ⊕ Initial Conditions (1)
 - ⊕ Output (1)
 - ⊕ Mesh
 - ⊕ Solution (1)
 - ⊕ Database Entities

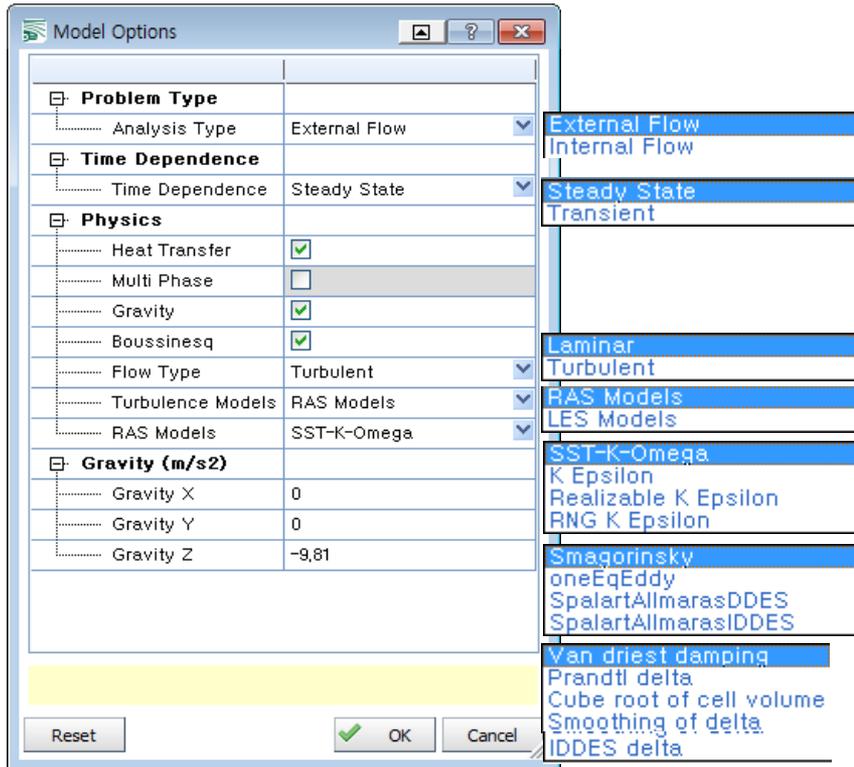
Top-Down
방식의
직관적인
모델 설정
구조

2. Visual-CFD 주요 기능

Model Options

- motorBike *더블 클릭!*
- Model Options
- Phase
- Interaction
- Bounding Box (6)
- Surface Parts (13)
- Interface Parts
- Primitive Parts
- Volume Parts (1)
- Materials (2)
- Boundary Conditions (4)
- Volume Conditions
- Initial Conditions (1)
- Output (1)
- Mesh
- Solution (1)
- Database Entities

- 해석 타입 및 솔버 종류 선택
- 외부/내부 유동, 정상/비정상 상태, 층류/난류, 열전달, 2상유동, 난류모델, 중력 등
- 선택된 내용에 따라 OpenFOAM 솔버 자동 선택



Visual-CFD v13.0 기준 지원 솔버

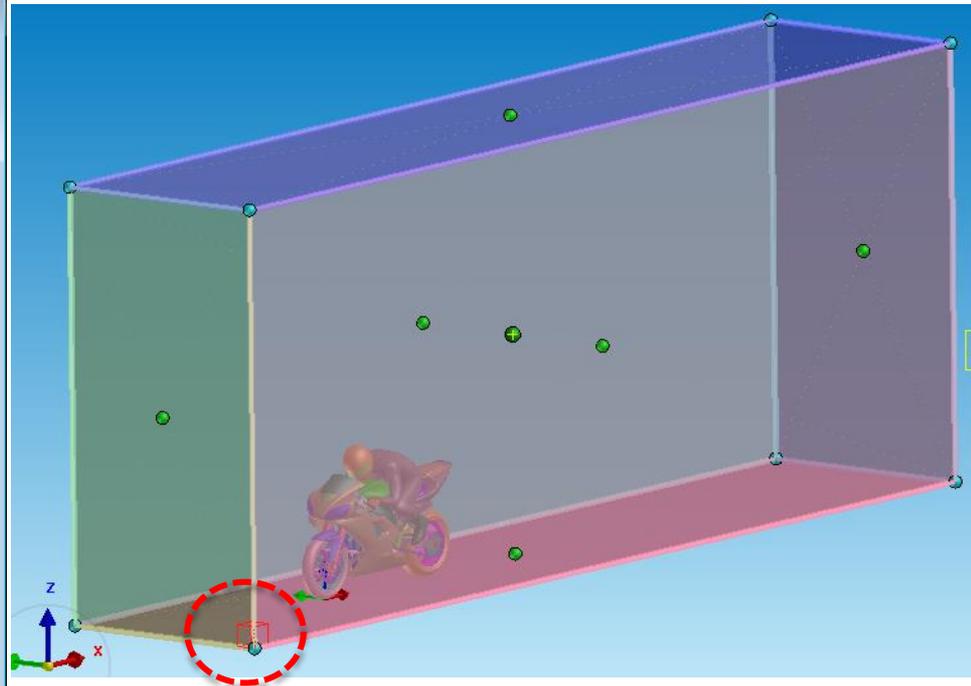
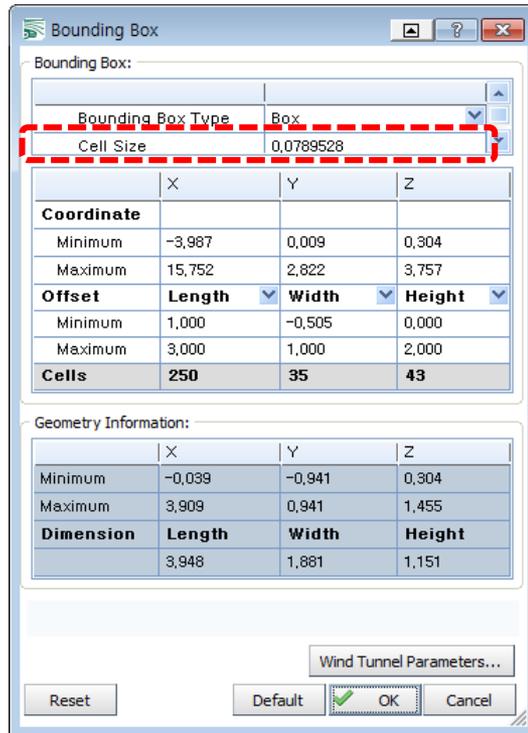
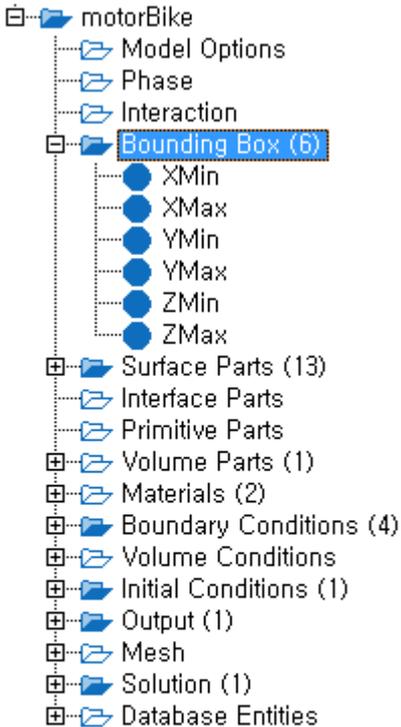
LIST OF OpenFOAM® SOLVERS SUPPORTED

simpleFoam
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 rhoPimpleFoam
 buoyantSimpleFoam
 buoyantPimpleFoam
 buoyantBoussinesqSimpleFoam
 buoyantBoussinesqPimpleFoam
 interFoam
 multiphaseEulerFoam
 interDyMFoam
 pimpleDyMFoam
 rhoPimpleDyMFoam
 chtMultiRegionSimpleFoam
 chtMultiRegionFoam

2. Visual-CFD 주요 기능

Bounding Box

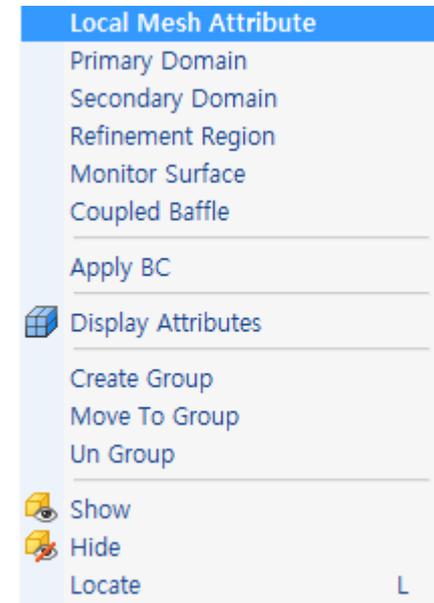
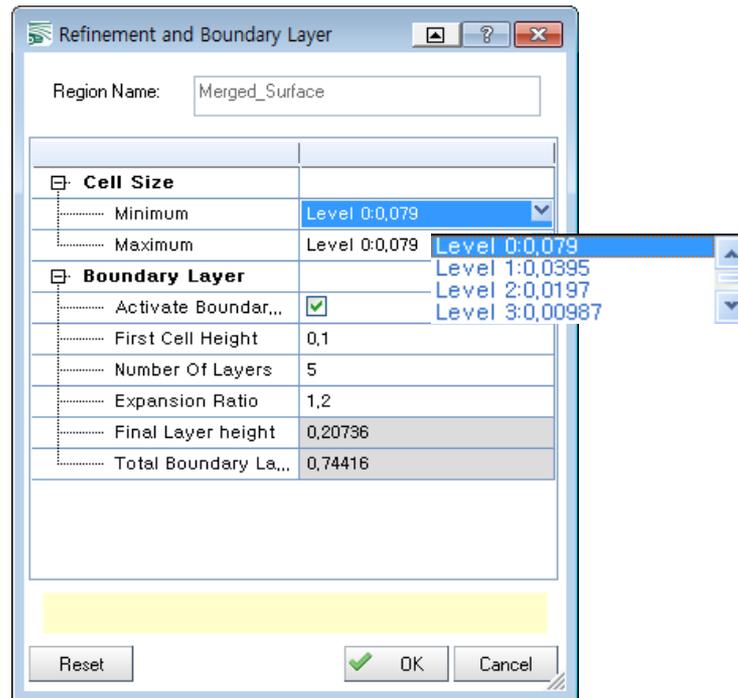
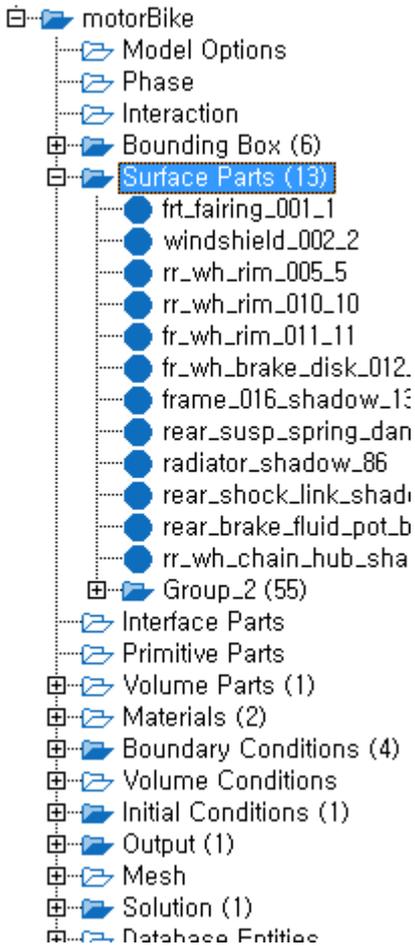
- Background Grid 설정 (OpenFOAM의 blockMesh)
- 화면상 드래그, 좌표, 상대크기, 자동설정 등 다양한 방법으로 설정 가능
- 화면상 최대격자 크기 표시로 직관적 판단 가능



2. Visual-CFD 주요 기능

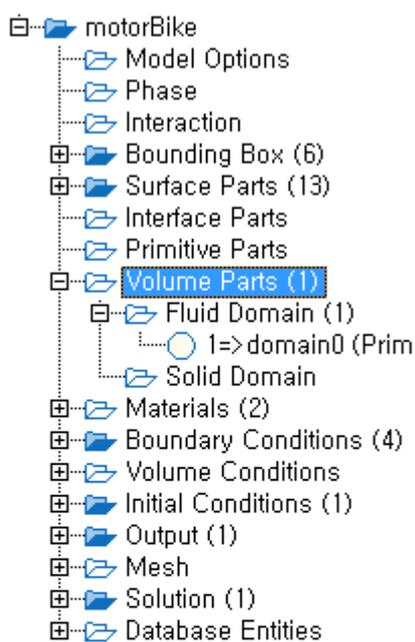
Surface Parts

- 파트 별 표면 격자 조건 설정 (크기 및 경계층)
- 최대격자 대비 크기로 설정 (OpenFOAM 기본 설정)
- 파트 이름변경, 그룹생성 등 부가기능 사용 가능

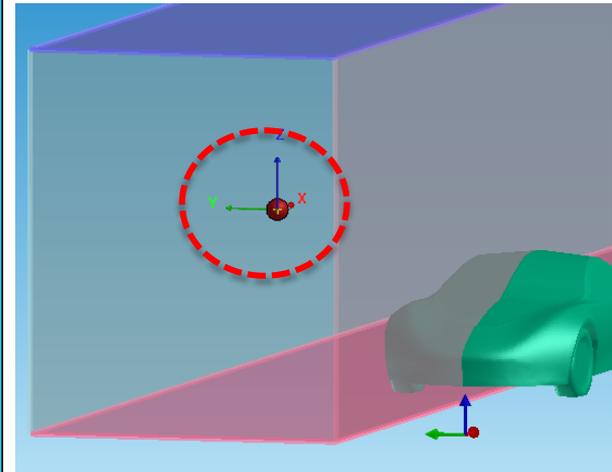
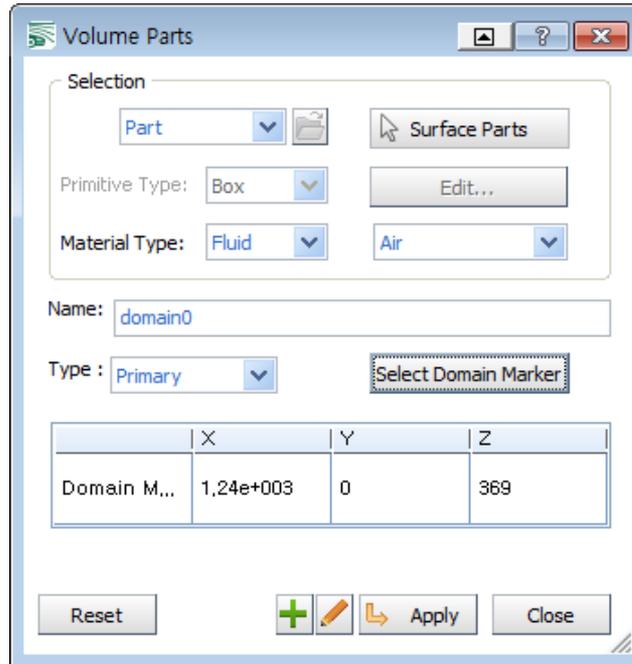


2. Visual-CFD 주요 기능

Volume Parts



- 해석 영역(볼륨) 위치 정보 설정 (SnappyHexMesh의 “locationInMesh”)
- 좌표 직접 입력 또는 화면상 마우스 드래그 가능
- 멀티도메인 및 유체/고체영역 설정
(ESI OpenFOAM+ 사용 시 각 도메인 내부 포인트만 입력)



2. Visual-CFD 주요 기능

Material Properties

- motorBike
 - Model Options
 - Phase
 - Interaction
 - Bounding Box (6)
 - Surface Parts (13)
 - Interface Parts
 - Primitive Parts
 - Volume Parts (1)
 - Materials (2)**
 - Fluids (1)
 - 1=>Air
 - Solids (1)
 - Boundary Conditions (4)
 - Volume Conditions
 - Initial Conditions (1)
 - Output (1)
 - Mesh
 - Solution (1)
 - Database Entities

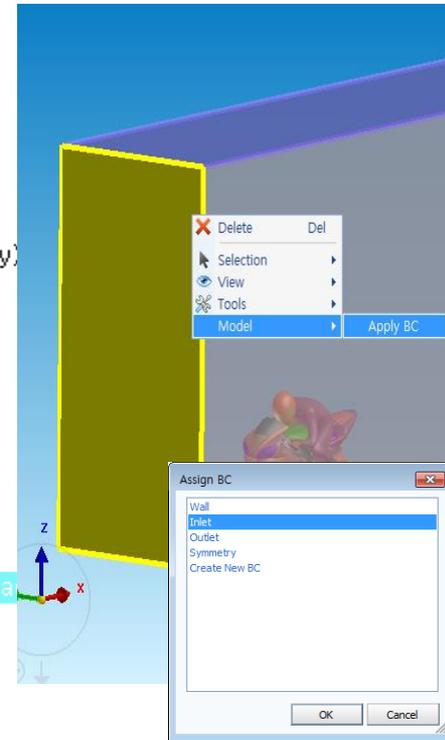
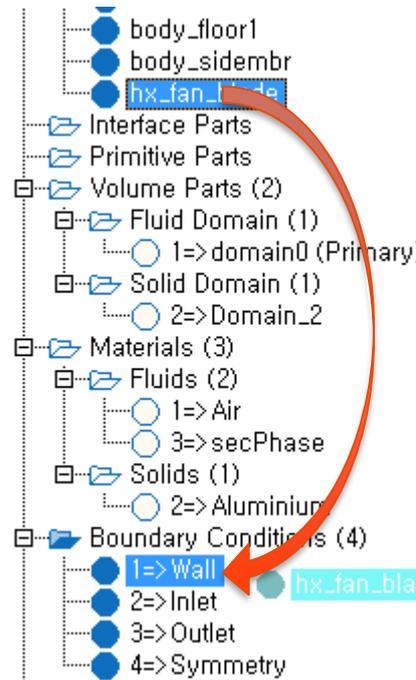
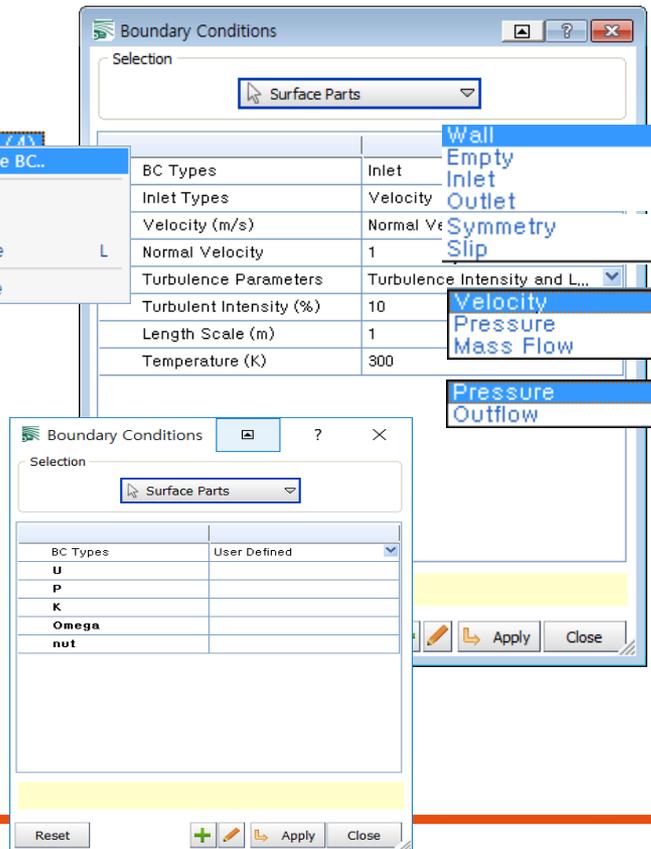
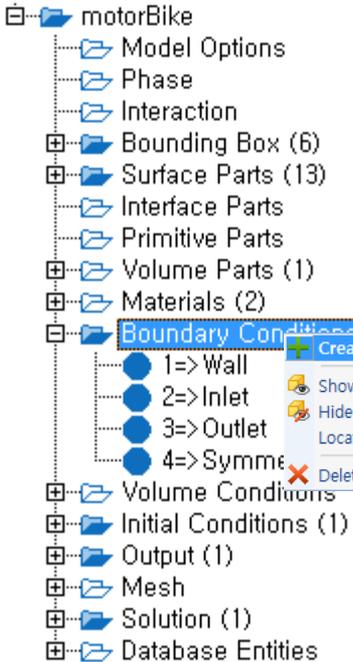
- 유체/고체 영역의 물성치 입력
- 솔버 타입에 따라 선택/입력값 변경됨

The image displays two side-by-side screenshots of the 'Material' dialog box in a software interface. The left window shows the 'Material' type set to 'Fluid' and the material name as 'Air'. Under the 'Density' section, the value is 'Constant' with a value of '1,1765'. A tooltip is visible over the 'Constant' value, showing 'Ideal Gas' and 'Constant' as options. The 'Viscosity' section is set to 'Newtonian' and 'Constant' with a dynamic viscosity of '1,846e-005'. The 'Thermal Properties' section includes 'Molecular Weight (g/m...)' at 28,966, 'Heat Capacity (J/kg-K)' at 1006,43, and 'Prandtl Number' at 0,7. The right window shows the 'Material' type set to 'Solid' and the material name as 'Aluminium'. The 'Density' section shows 'Density (kg/m^3)' as 2719. The 'Thermal Properties' section includes 'Molecular Weight (g/mol)' at 26,98, 'Specific Heat (J/K-m^3)' at 871, and 'Conductivity (W/m-K)' at 202,4. Both windows have a 'Reset' button and 'Apply' and 'Close' buttons with icons.

2. Visual-CFD 주요 기능

Boundary Conditions

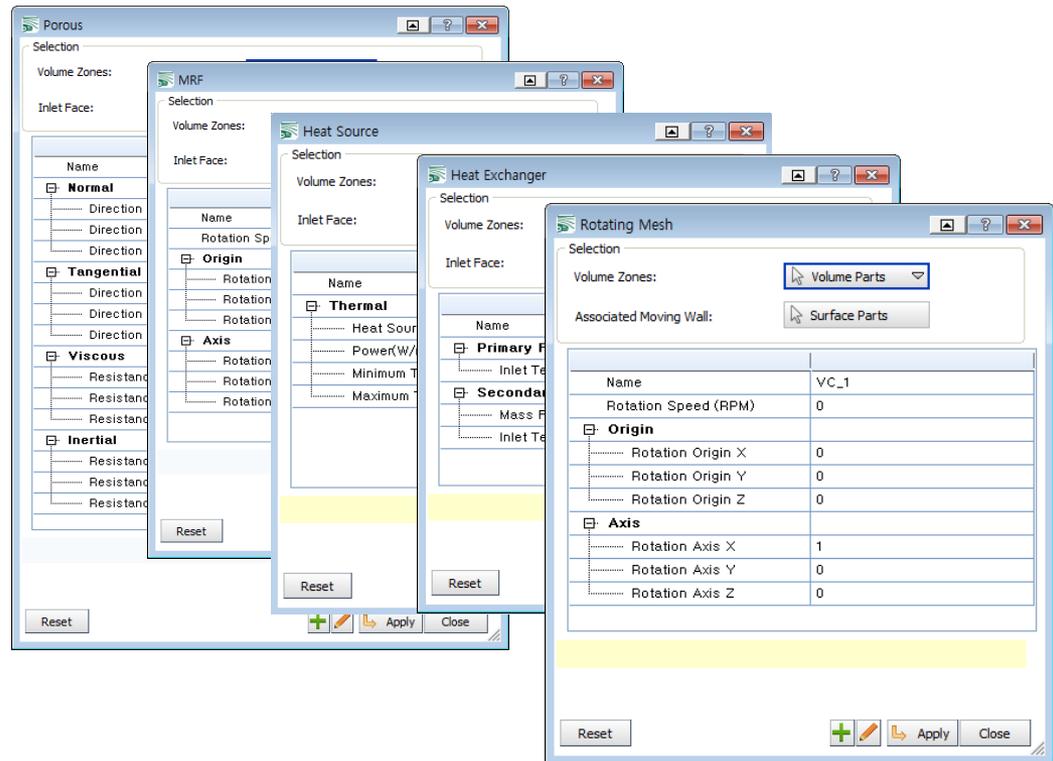
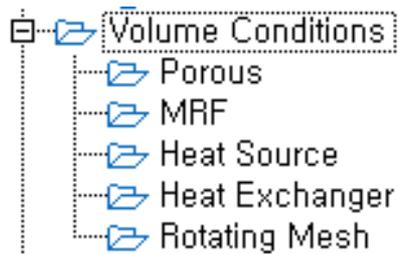
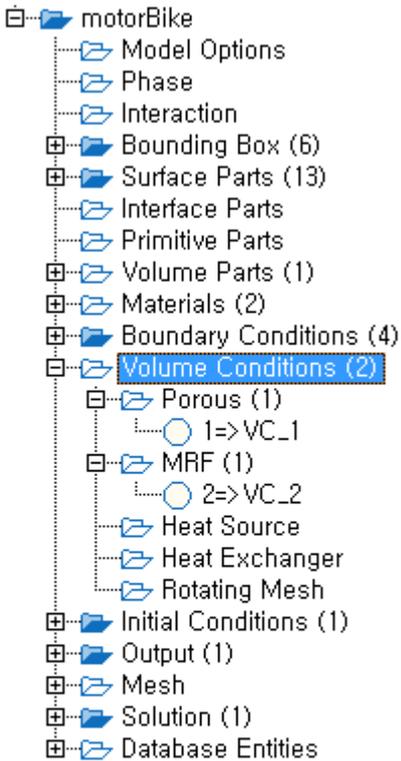
- 다양한 경계조건 타입 생성/설정 가능
- 트리상의 파트 드래그/드랍 또는 화면상 선택으로 경계조건 부여
- 사용자 BC 생성 가능



2. Visual-CFD 주요 기능

Volume Conditions

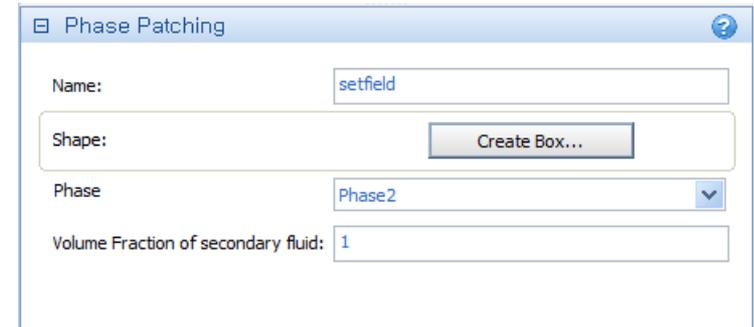
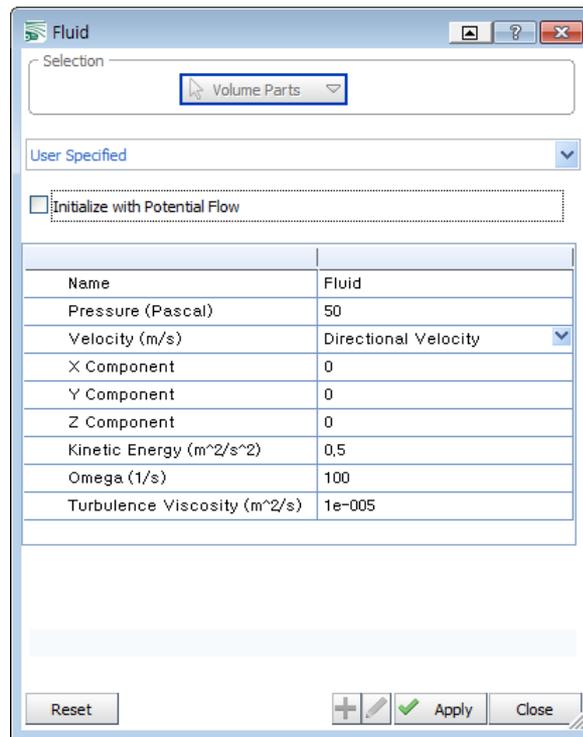
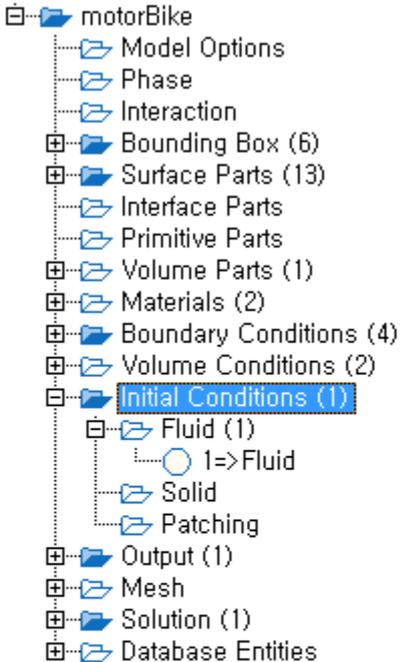
- 5가지 볼륨 조건 설정 가능
- 특정 파트의 center, axis 를 화면상의 노드 클릭으로 계산 가능
- Rotating Mesh는 Moving 영역 및 파트 설정 필요



2. Visual-CFD 주요 기능

Initial Conditions

- 유동장 초기값 설정
- potentialFoam 실행 여부 설정
- VOF 적용 시 초기 VOF 영역 설정 (box)

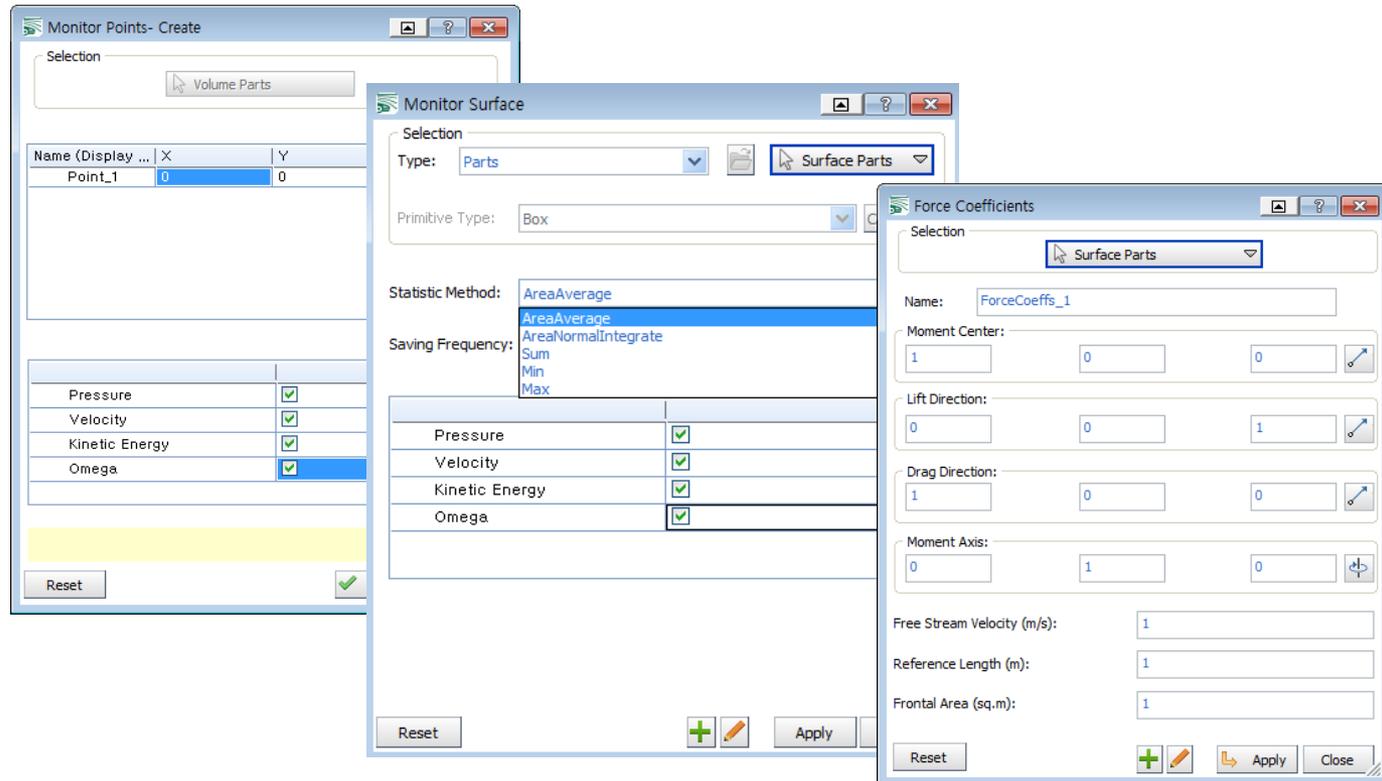


2. Visual-CFD 주요 기능

Output

- motorBike
 - Model Options
 - Phase
 - Interaction
 - Bounding Box (6)
 - Surface Parts (13)
 - Interface Parts
 - Primitive Parts
 - Volume Parts (1)
 - Materials (2)
 - Boundary Conditions (4)
 - Volume Conditions (2)
 - Initial Conditions (1)
 - Output (2)**
 - Monitor Points
 - Monitor Surface (1)
 - 1=>Surface_1
 - Monitor Volume
 - Force Coefficients (1)
 - 1=>ForceCoeffs_1
 - Mesh
 - Solution (1)
 - Database Entities

- 해석 시 특정 유동장 값 출력을 위한 옵션 설정 (모니터링)
- 포인트, 면, 볼륨에 대한 다양한 변수값 계산 기능 설정 가능
- 기본 변수 외 가공된 값 계산 설정 가능 (현재 항력계수 설정 제공)

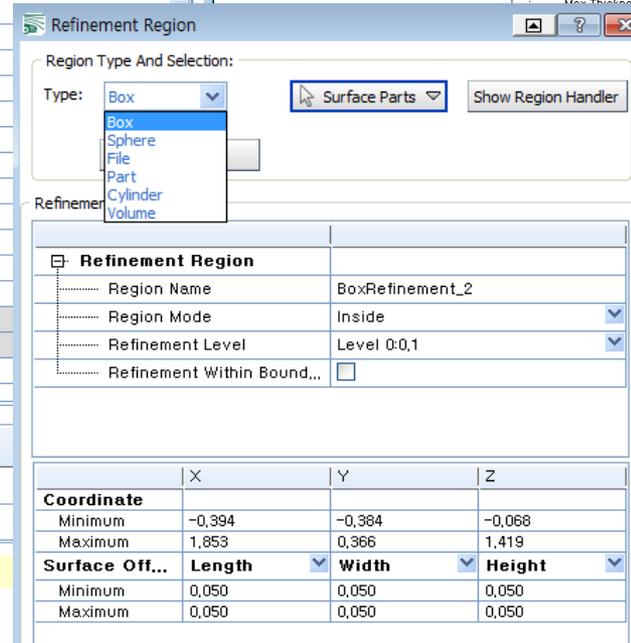
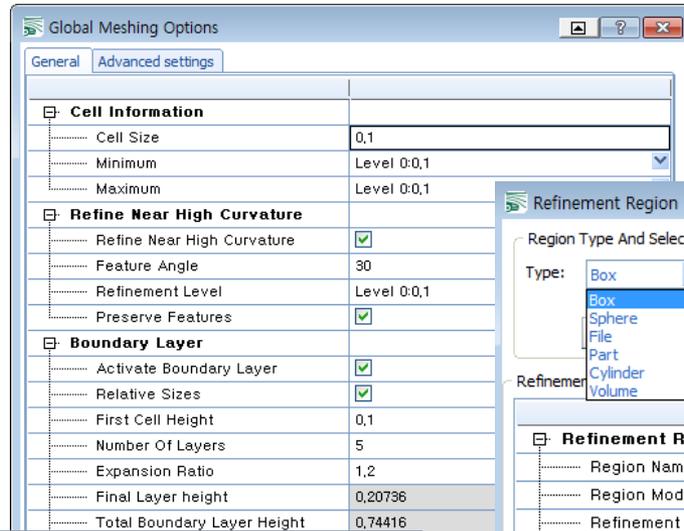


2. Visual-CFD 주요 기능

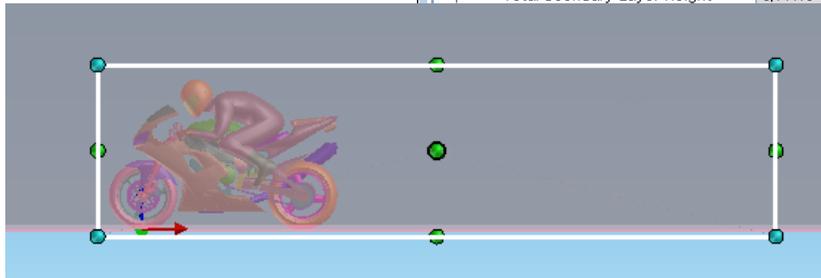
Volume Mesh

- 글로벌 격자 조건 설정
- 격자 Refine 영역 설정 (box, cylinder, sphere, 외부 표면 등)
- snappHexMesh의 세부 옵션 설정

- motorBike
 - Model Options
 - Phase
 - Interaction
 - Bounding Box (6)
 - Surface Parts (13)
 - Interface Parts
 - Primitive Parts
 - Volume Parts (1)
 - Materials (2)
 - Boundary Conditions (4)
 - Volume Conditions (2)
 - Initial Conditions (1)
 - Output (2)
 - Mesh (2)
 - Refinement Region (2)
 - 1=>BoxRefinement
 - 2=>BoxRefinement
 - Cells Zone Splitting
 - Solution (1)
 - Database Entities



General		Advanced settings	
Castellated Mesh	<input checked="" type="checkbox"/>		
Snap	<input checked="" type="checkbox"/>		
Merge Tolerance		1e-008	
Castellated Mesh			
Max Local Cells		200000000	
Max Global Cells		300000000	
Min Refinement Cells		20	
Cells between levels		4	
Max Load Unbalance		0,1	
Free Standing Zone Faces	<input checked="" type="checkbox"/>		
Feature Snapping			
Snap Tolerance		2	
Implicit Feature Snapping	<input type="checkbox"/>		
Explicit Feature Snapping	<input checked="" type="checkbox"/>		
Multi-Region Snapping	<input checked="" type="checkbox"/>		
Detect Near Surfaces Snapping	<input checked="" type="checkbox"/>		
Snap Iterations			
Smoothing Iterations		3	
Displacement Iterations		50	
Snap Relaxation Iterations		5	
Edge Snapping Iterations		10	
Layers Growth control			
Feature Angle		85	
Slip Feature Angle		30	
nGrow		0	
Buffer Cells No Extrude		0	
Min Median Axis Angle		90	
Max Face Thickness Ratio		0,2	
Max Thickness to Medial Ratio		0,3	
		0,001	



2. Visual-CFD 주요 기능

Numerical Solver

- motorBike
 - Model Options
 - Phase
 - Interaction
 - Bounding Box (6)
 - Surface Parts (13)
 - Interface Parts
 - Primitive Parts
 - Volume Parts (1)
 - Materials (2)
 - Boundary Conditions (4)
 - Volume Conditions (2)
 - Initial Conditions (1)
 - Output (2)
 - Mesh (2)
 - Solution (1)**
 - Numerical Solver (1)**
 - 1=>Fluid
 - Simulation Control
 - Database Entities

- 변수 별 수렴도, 완화계수, 이산화 기법 등 선택 가능
- 격자 수준에 따라 기본 설정 사용 가능
- 특정 iteration 후 적용 기법 변경 가능

Label	Solver	Pre-Conditioner	Actual Tolera...	Relative Toler...
P	GAMG	GaussSeidel	1e-008	0,05
U	smoothSol...	GaussSeidel	1e-012	0,1
k	smoothSol...	GaussSeidel	1e-012	0,1
Omega	smoothSol...	GaussSeidel	1e-012	0,1

P	0,2
U	0,5
k	0,3
Omega	0,3

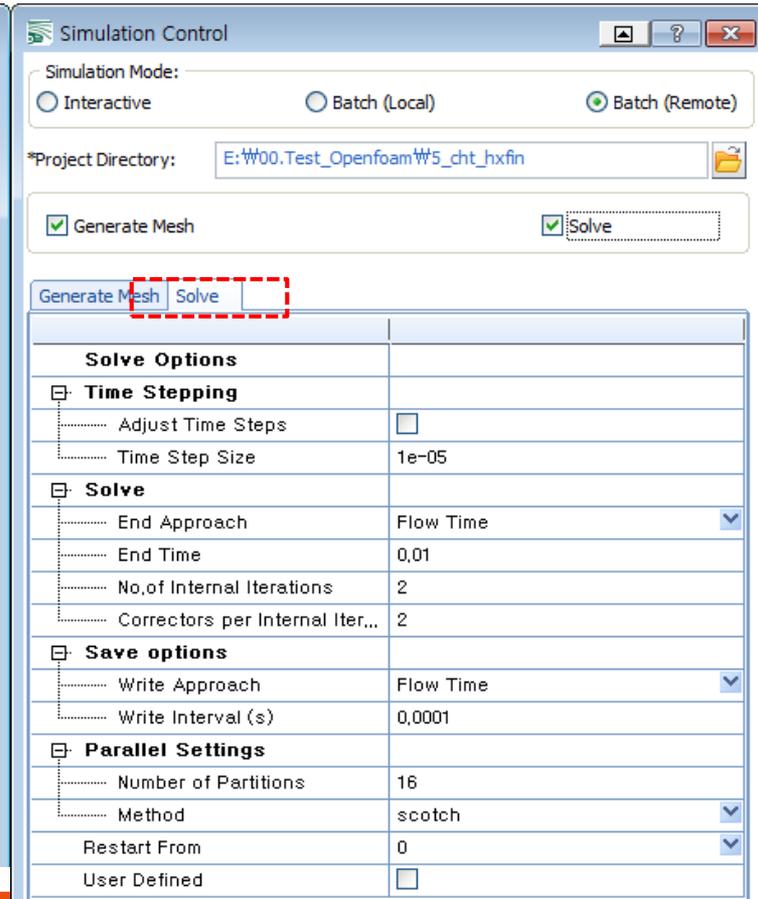
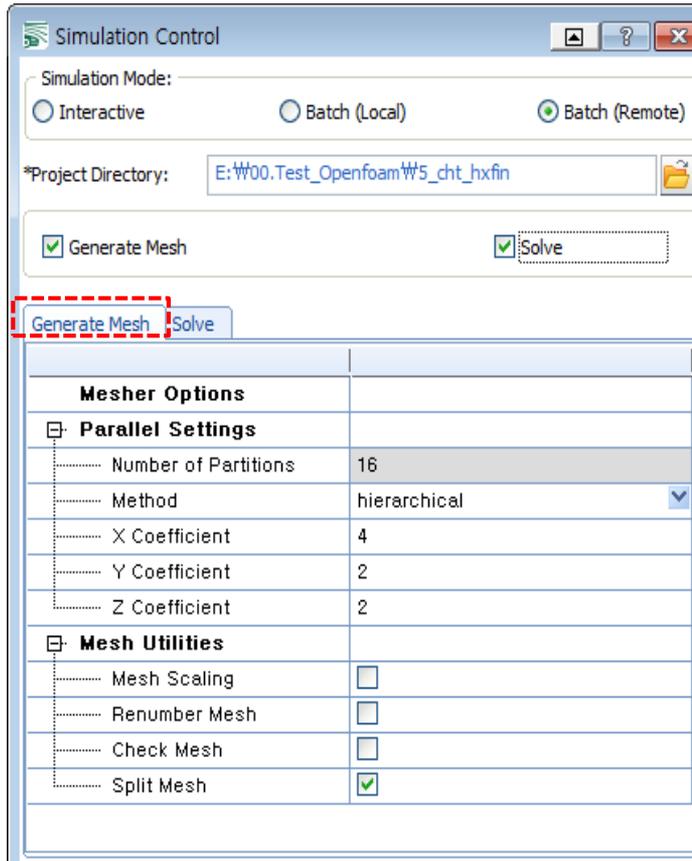
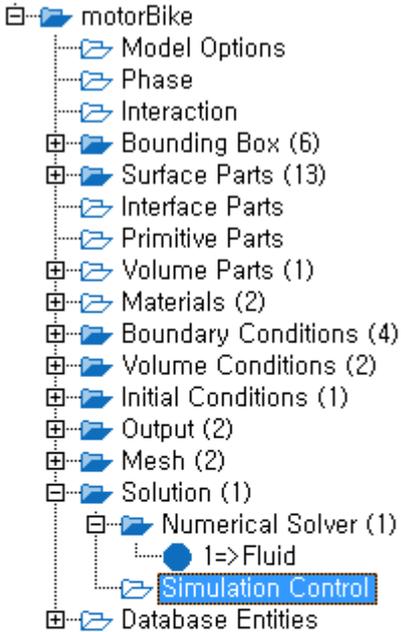
Velocity	1st Order Upwind
k	1st Order Upwind
Omega	1st Order Upwind
Switch to higher order schemes	<input checked="" type="checkbox"/>
Iteration Number After Scheme Sta...	200
Velocity	2nd Order Upwind
k	2nd Order Upwind
Omega	2nd Order Upwind

Time	steadyState
Laplacian Schemes	Gauss linear limited
Cell Face Normal Grad Schemes	limited
Gradient Schemes	
default	cellLimited Gauss linear
grad(U)	Gauss linear
grad(p)	Gauss linear
Interpolation Schemes	
default	linear
Switch to higher order schemes	<input checked="" type="checkbox"/>
Laplacian Schemes Second Order	Gauss linear limited
Cell Face Normal Grad Schemes Sec...	limited
Gradient Schemes Second Order	
default	cellLimited Gauss linear
grad(U)	Gauss linear
grad(p)	Gauss linear
Interpolation Schemes Second...	
default	linear

2. Visual-CFD 주요 기능

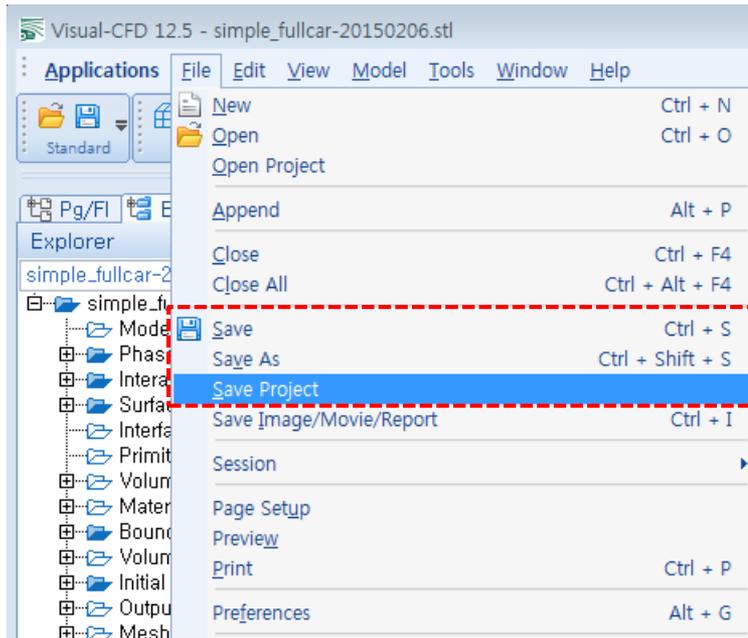
Simulation Control

- 격자생성 및 솔버 실행 조건을 설정 (실행 명령 스크립트 자동 생성)
- 병렬 여부 및 decompose 방식, 기타 유틸리티 사용 여부 선택 가능

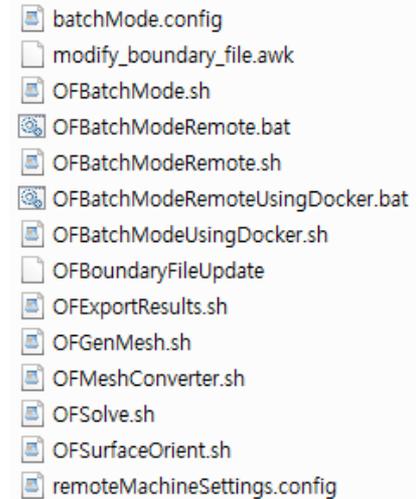
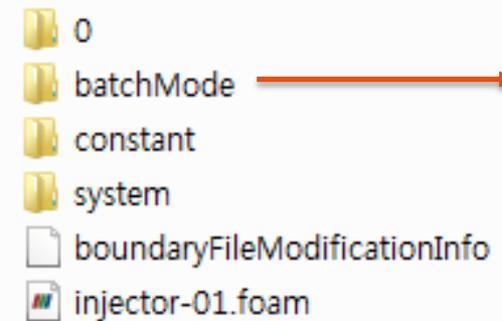


2. Visual-CFD 주요 기능

Save



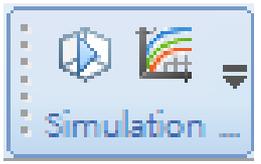
- Save/Save As : 자체 포맷 저장 (*.VDB)
- Save Project : OpenFOAM 케이스 저장 (폴더 구조 및 설정 파일, 실행 배치파일)



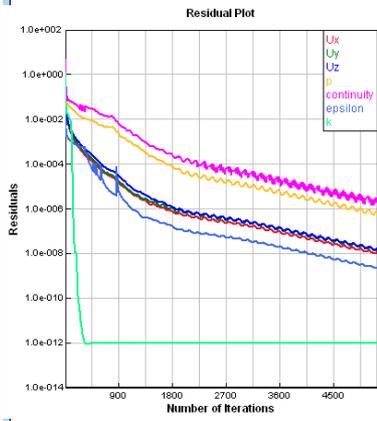
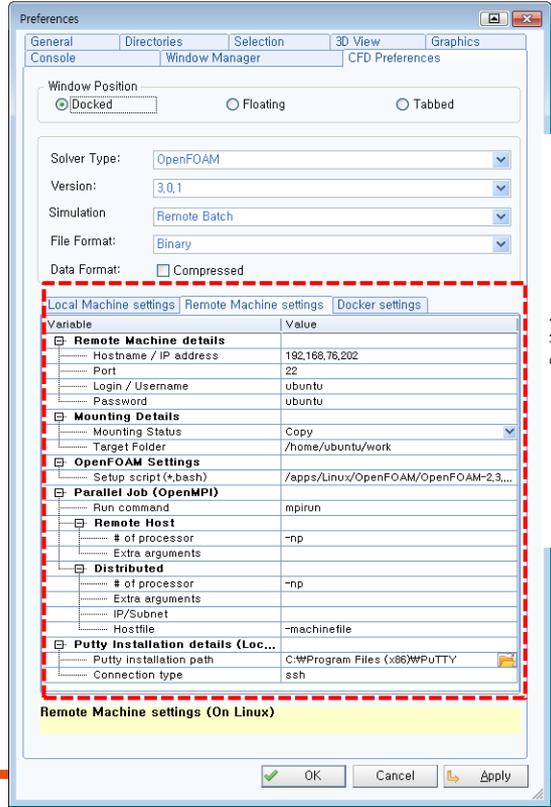
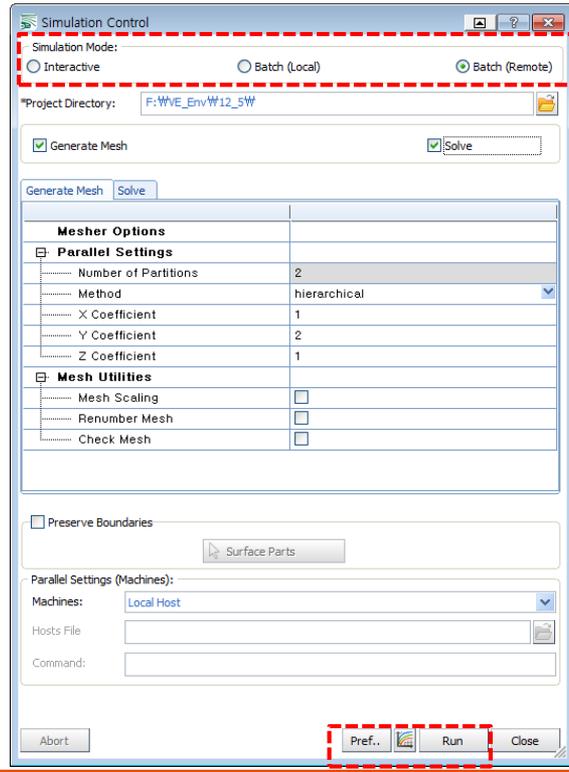
2. Visual-CFD 주요 기능

Run

- motorBike
 - Model Options
 - Phase
 - Interaction
 - Bounding Box (6)
 - Surface Parts (13)
 - Interface Parts
 - Primitive Parts
 - Volume Parts (1)
 - Materials (2)
 - Boundary Conditions (4)
 - Volume Conditions (2)
 - Initial Conditions (1)
 - Output (2)
 - Mesh (2)
 - Solution (1)
 - Numerical Solver (1)
 - 1=>Fluid
 - Simulation Control**
 - Database Entities



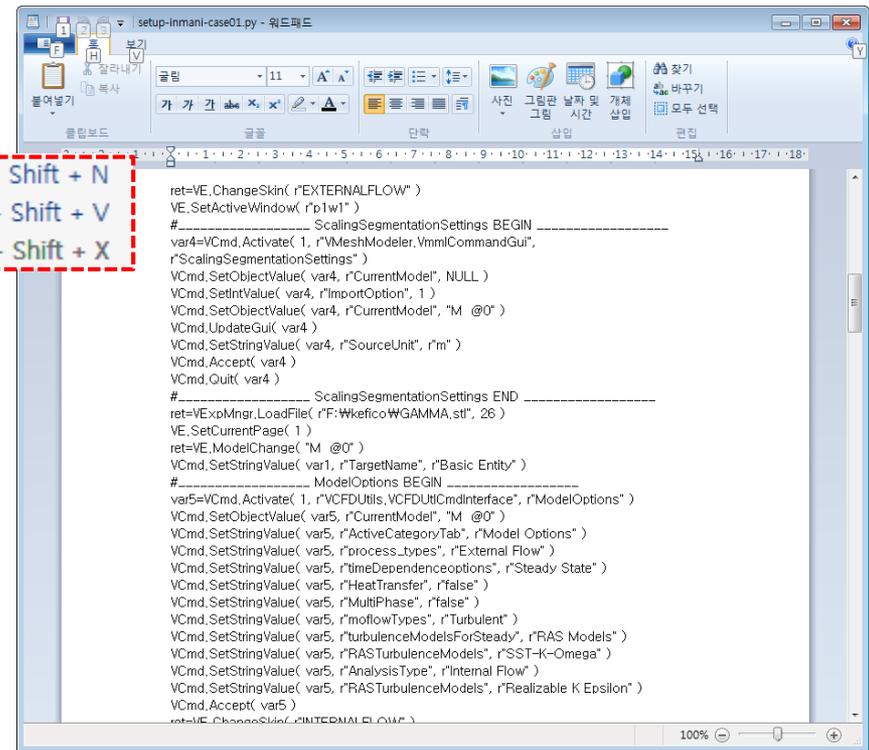
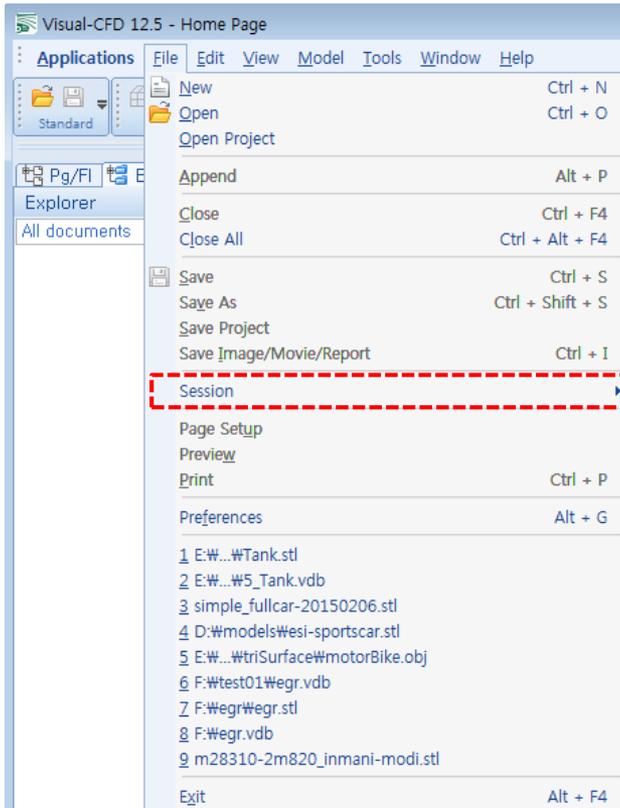
- 솔버 실행 방법 선택 (로컬 장비, 원격 장비, 독커 등)
- 매쉬 작성 및 솔버 선택적 실행
- 매쉬 및 솔버 실행 파라미터 설정 및 기타 유틸리티 실행여부 설정
- 솔버 수렴성 및 모니터링 값 Plot



2. Visual-CFD 주요 기능

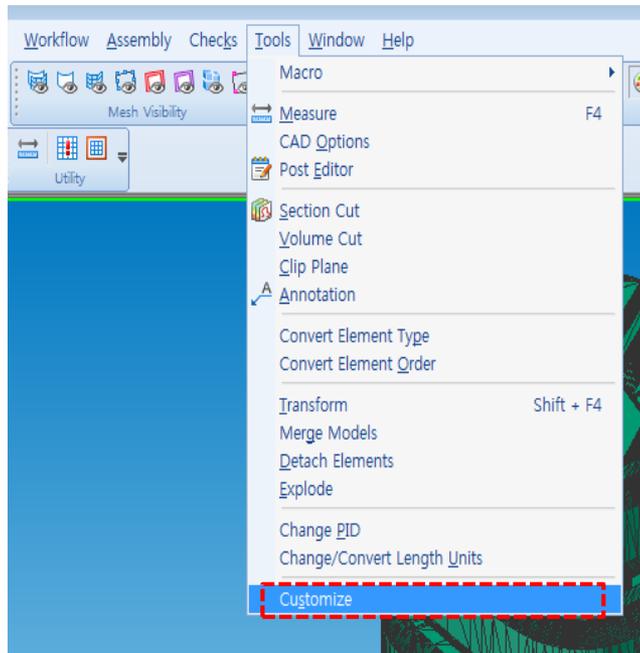
Macro Recording (Session)

- GUI에서 수행한 모든 작업을 매크로로 기록
- 해당 매크로를 파이썬 파일로 저장하여 활용
- 반복작업 및 자동화 구현에 매우 용이

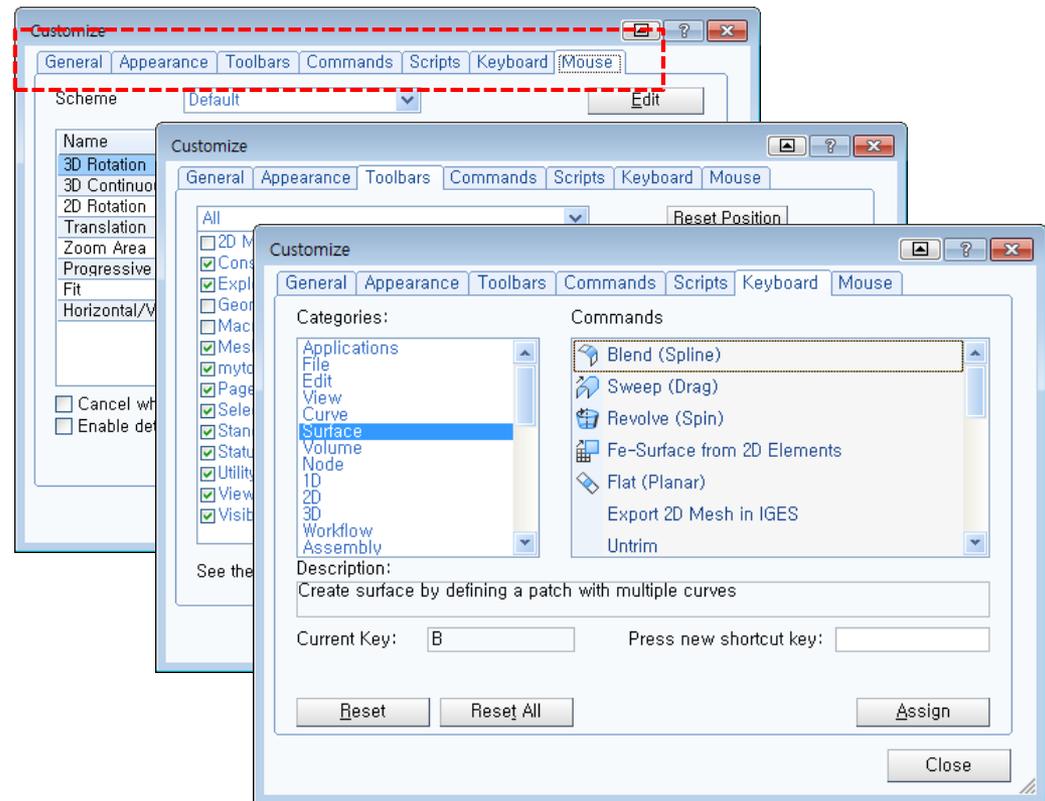


2. Visual-CFD 주요 기능

User Customization

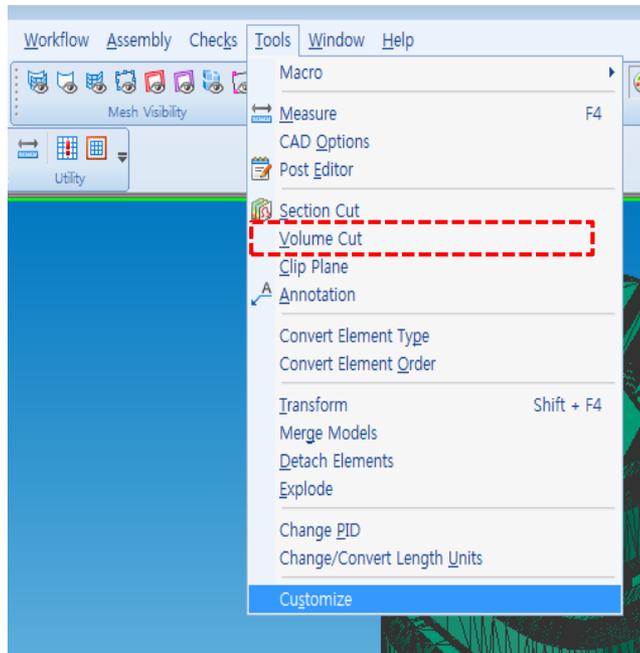


- GUI의 다양한 기능을 사용자 설정하여 사용 가능
- 대화창, 툴바, 단축아이콘, 단축키, 마우스 등

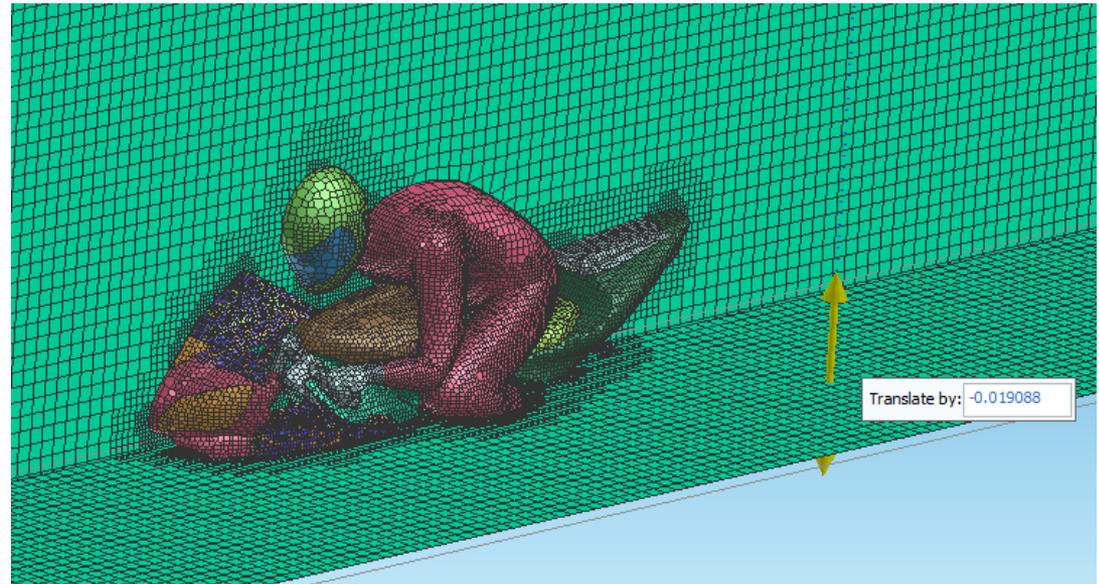


2. Visual-CFD 주요 기능

Volume Cut



- 작성된 볼륨 격자의 품질을 가시적으로 직접 확인
- 원하는 영역의 격자를 화면을 직접 드래그 하여 연속적으로 격자 품질 확인 가능



3. Visual-SDK

3. Visual-Process (SDK)

해석 자동화 프로세스 작성 툴

The screenshot displays the Visual-Process Executive 10.0 software interface. On the left, a workflow diagram titled 'Marine' is shown, enclosed in a dashed orange box. The diagram consists of the following steps: 'Create Project' (blue box), 'User Inputs' (blue diamond), 'Advance Inputs' (blue box), 'Mesh' (blue box), 'Simulation' (blue box), and 'PostProcessing' (blue box). Arrows indicate the flow from 'Create Project' to 'User Inputs', then to 'Advance Inputs', 'Mesh', 'Simulation', and finally 'PostProcessing'. A red callout bubble points to the 'User Inputs' step with the text '사용자 정의 Process'.

In the center, a 3D model of a car is visible within a coordinate system. A red callout bubble points to the model with the text '해석 모델 입력창'.

On the right, a 'Basic User Inputs' dialog box is open, also enclosed in a dashed orange box. It contains various input fields and checkboxes. A red callout bubble points to the top of this dialog with the text '해석 조건 입력창'. The inputs include: Ship speed (3.0 m/s), Pitch Angle (2.0 deg), Yaw Angle (0.0 deg), Water Level (0.45 times max height of ship), Center of Rotation (-2.929, 0.0, 0.2 in m), Mesh Settings (Surface Size on Ship body: 16m Coarse to 0.25m Fine), Simulation Settings (Transient Run, Floating Ship 6-DOF, Mass of Ship: 412.73 kg, Moment of Inertia: 40.0, 921.0, 921.0 kg-m2), and Run Options (Parallel Run, No of Partitions: 2, Total Time: 50 sec, Save Data at: 0.05 sec). A 'Save Input' button is at the bottom.

At the bottom of the interface, a console window shows the following text: 'Reading STL data in ASCII format..', 'Reading solid hull_bottom', 'Reading solid hull_top', 'Reading solid hull_back', 'MODEL STATISTICS', 'Nodes = 58033', '2D Elements = 116062', 'Tria = 116062', 'Parts = 3', 'Model box size = (6.27559, 0.858505, 0.572322) Diagonal length =', and 'File C:\Users\esipune\FILES\DTC_in_m.stl loaded'. A Python 2.7.3 command prompt is also visible on the right side of the console area.

3. Visual-Process (SDK)

해석 자동화 프로세스 작성 툴

ESI의 통합 인터페이스
Visual-Environment 환경

Drad & Drop, 마우스
클릭으로 만드는
직관적인 사용자 Process

Visual-SDK (Execute Process Builder) 11.5 - NewTemplate

Block Library

- Default Blocks
 - Decision
 - SubProcess
 - NormalBlock
 - Terminator
- Library Blocks
 - Job Submission
 - Macro Blocks
 - Existing Process Blocks
 - NVH-IA
 - PAM-CRASH Processes

Process Flow Diagram:

```
graph TD; NB[NormalBlock] --> SP[Sub Process]; SP --> D{Decision}; D -- Left --> SP2[Sub P]; D -- Right --> N[Normal];
```

NormalBlock Settings

Block | Display | Variables | GUI | Script | Interface

General

Name: NormalBlock

Label: NormalBlock

Tool Tip:

Description:

Show As Image

Image File: imagesW5.ico

Script Type: PYTHON

Help Topic:

Interface:

Command:

Method:

Location & Dimension

Location X: 7.8

Location Y: 1.0

Height: 0.6

Width: 2.05555

Ports

#	Port
1	
2	
3	
4	
5	
6	

사용자만의 변수
추가/사용

NormalBlock Settings

File | Edit | View | Align

Block | Display | Variables | GUI | Script | Interface

NormalBlock

Button

사용자만의 추가
GUI 작성 기능

NormalBlock Settings

Block | Display | Variables | GUI | Script | Interface

```
1 # -*- coding: UTF-8 -*-
2
3 File Name: NormalBlock.py
4 Module Information: NormalBlock Generated by Visual
5 Design:
6 GUI Variables:
7 UNDO Implemented:
8 Date of Creation:
9 Revision History:
10 Copy write Information:
11
12 import win32com.client
13 import win32api
14 from constants.processconstants import *
15 import CustomGui
```

Open in a new window | Find | Replace | Check | Reload | Execute | 8 | 18

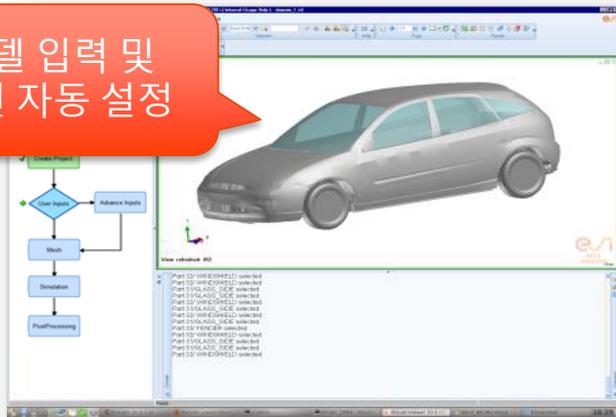
OK | Cancel | Apply | Help

모든 기능에 대한
Python 스크립트 지원

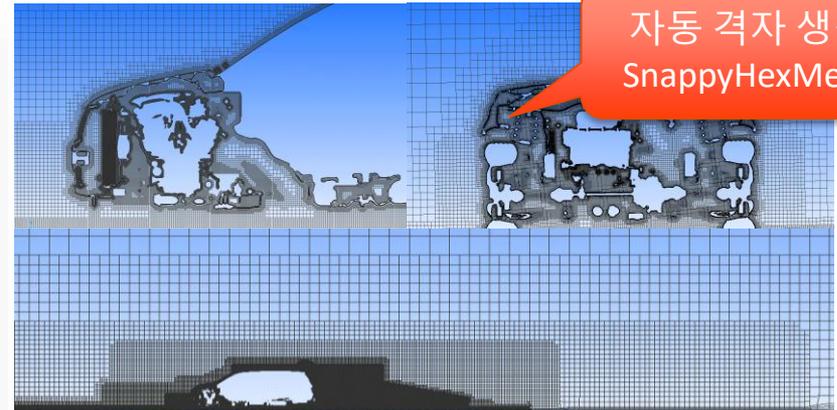
3. Visual-Process (SDK)

Visual-Process를 이용한 OpenFOAM 해석 자동화 사례

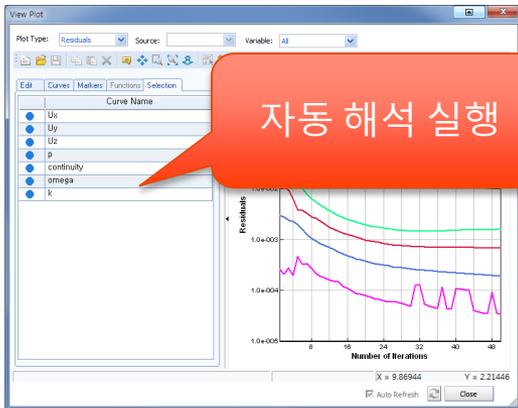
해석 모델 입력 및
해석 조건 자동 설정



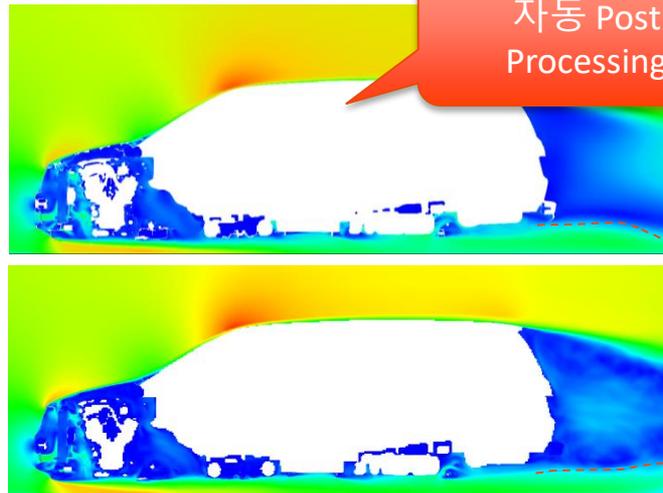
자동 격자 생성
SnappyHexMesh



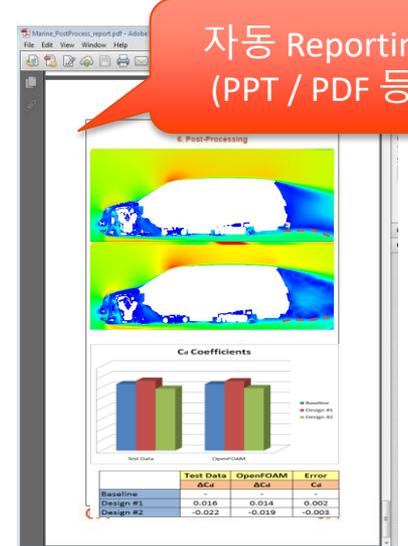
자동 해석 실행



자동 Post
Processing



자동 Reporting
(PPT / PDF 등)





For more information,
please contact ESI Korea
dgl@esi-group.com