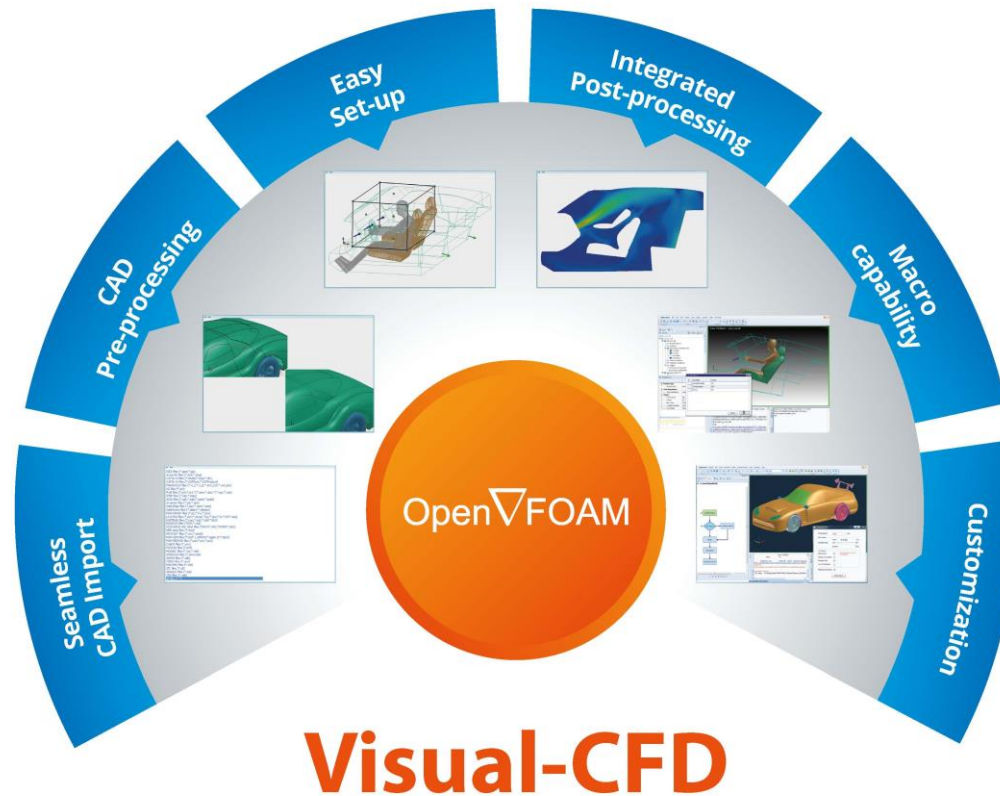


A Powerful GUI for OpenFOAM®

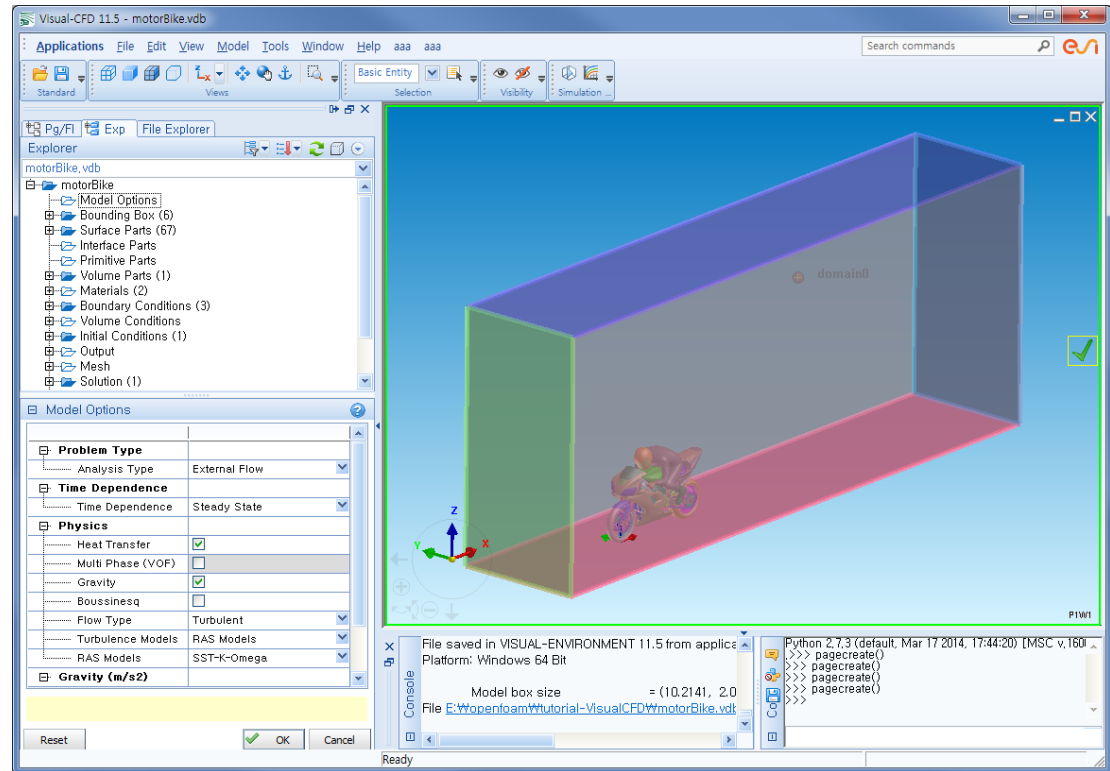


Contents

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

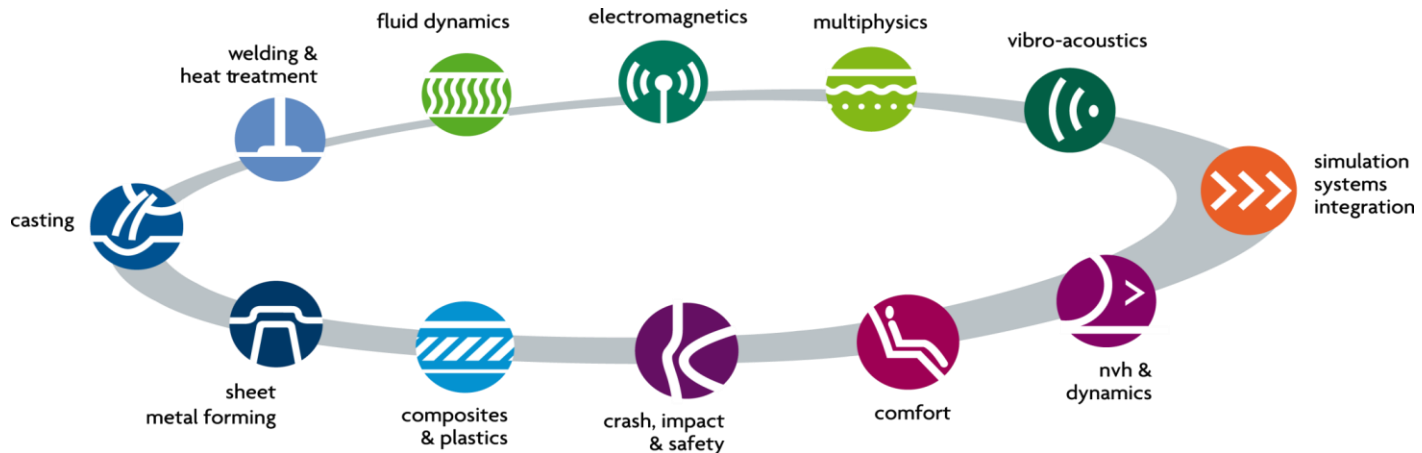


3. Visual-Process(SDK)

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

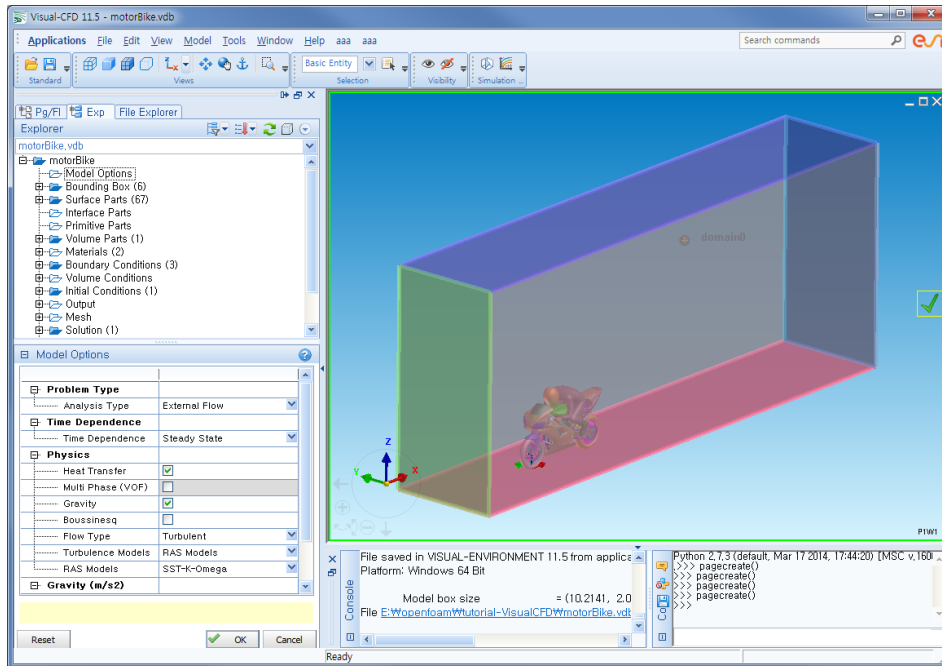
www.openfoam.com



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 맞춤 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+
-------------------	---------------

1. Visual-CFD 개요

기본 인터페이스

Top-Down 방식의
직관적인 모델 설정

OpenFOAM 다양한
변수/기능을 GUI를
통하여 설정

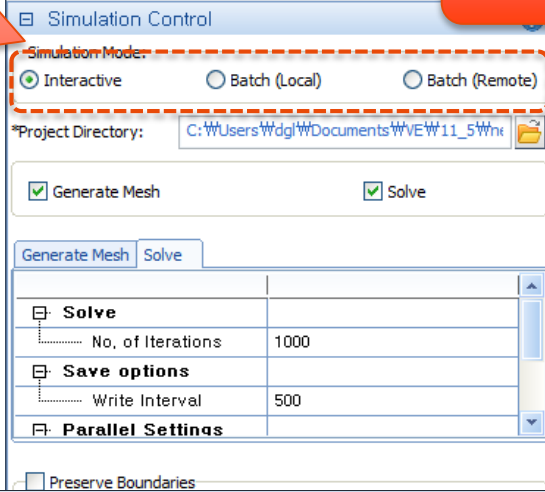
Model Display & Interaction
(화면상에서의 파트선택/설정,
도메인, refine영역 크기설정 등)

실시간
Console output

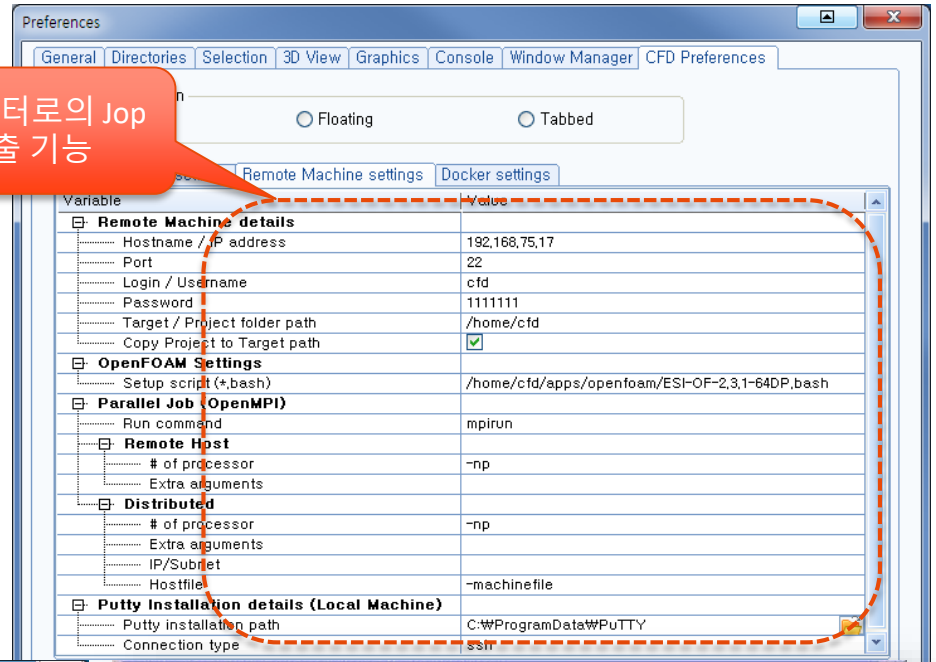
실시간
Script 실행

1. Visual-CFD 개요

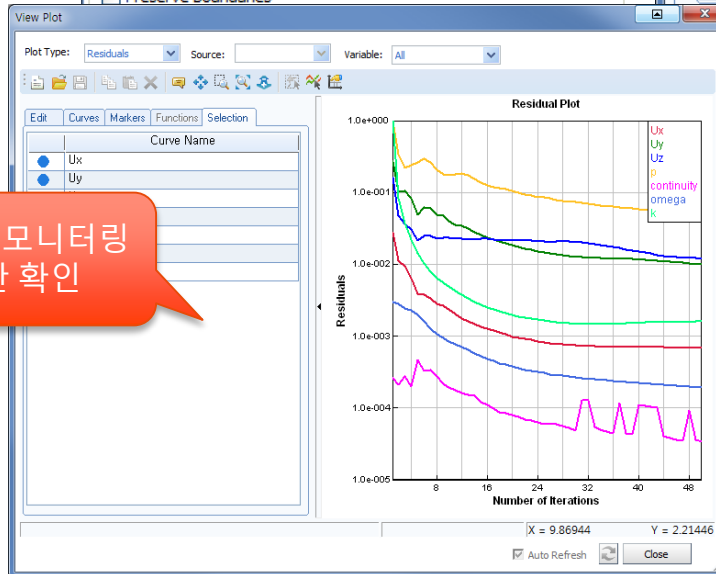
다양한 OpenFOAM
솔버 실행 방식



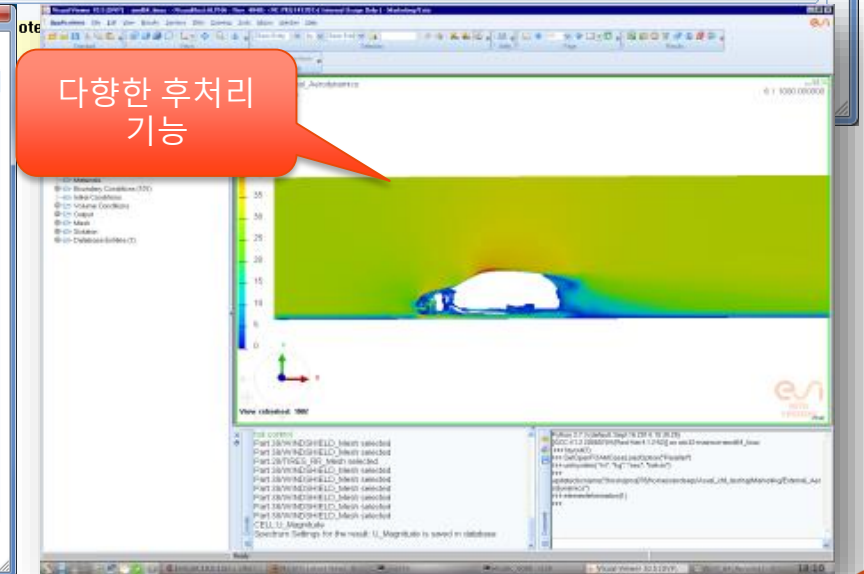
클러스터로의 Job
제출 기능



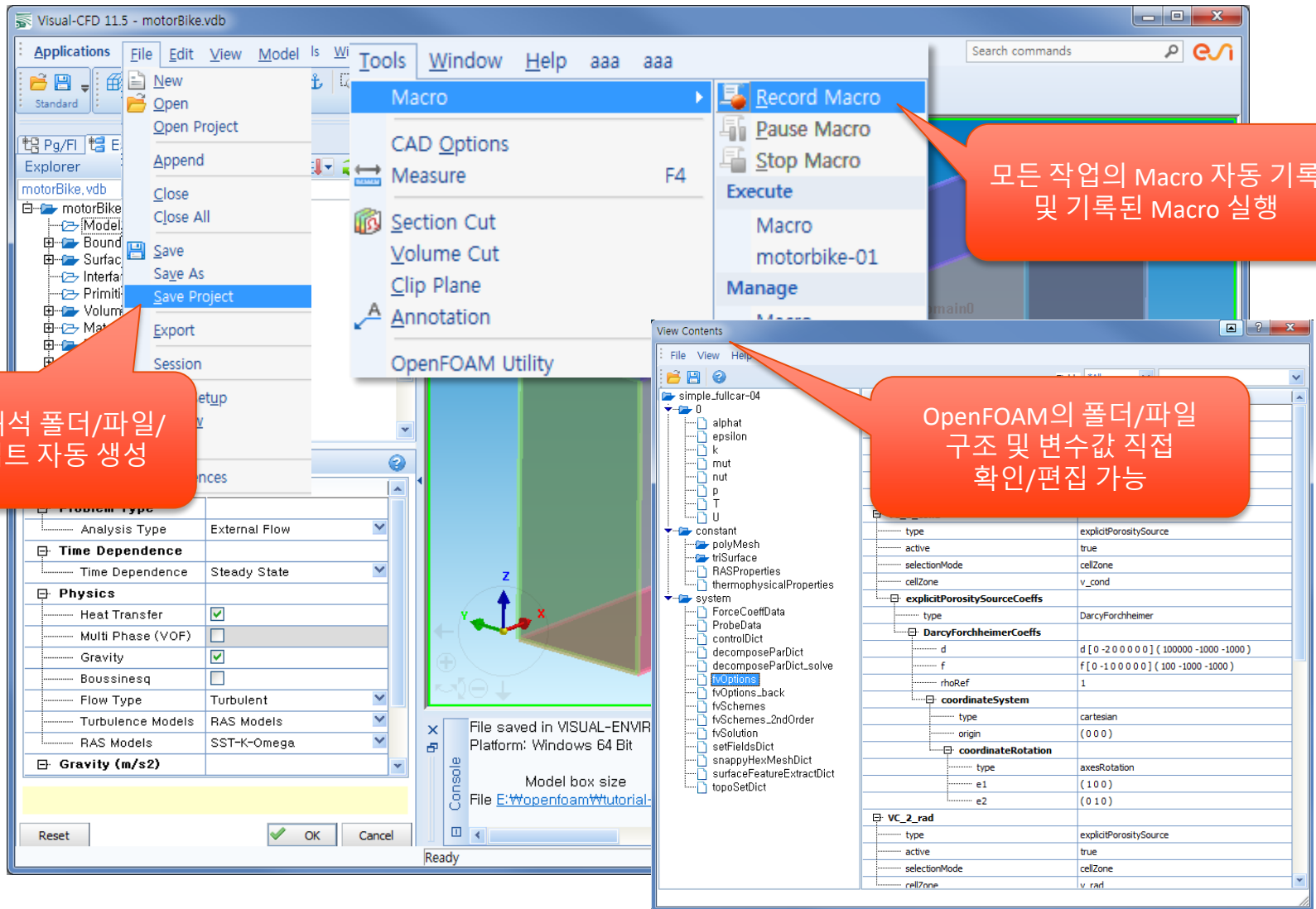
수렴변수 및 모니터링
값 실시간 확인



다양한 후처리
기능



1. Visual-CFD 개요

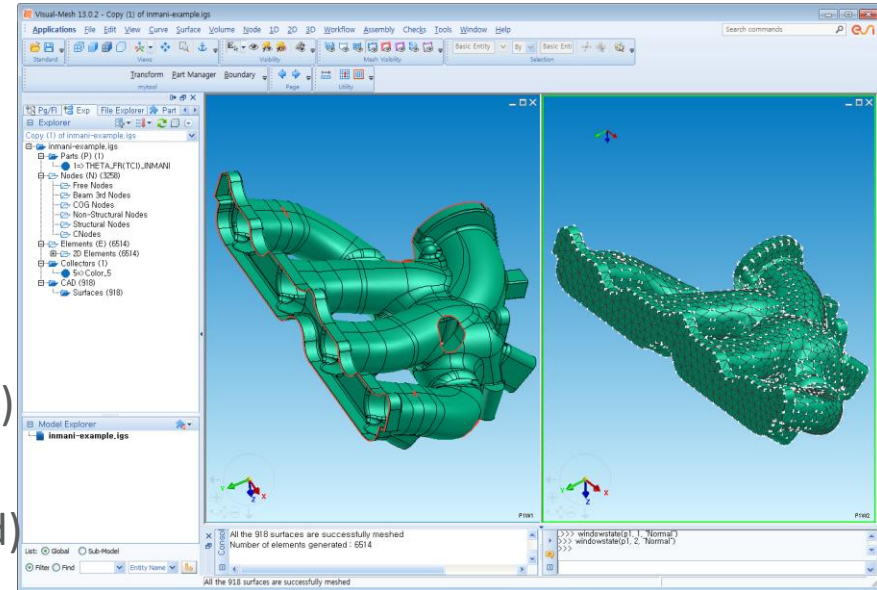


1. Visual-CFD 개요

Visual-Mesh, Visual-Viewer

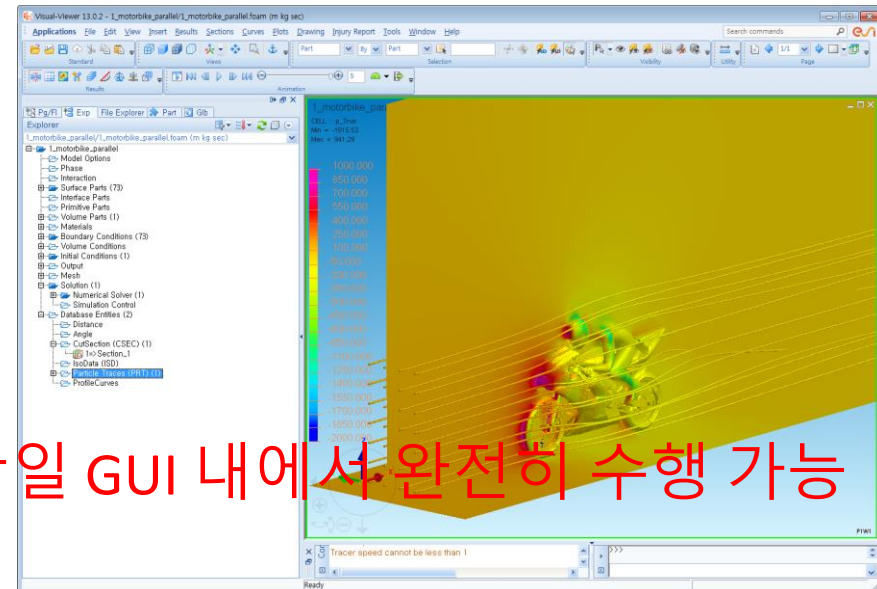
- **Visual-Mesh®**

- ▶ 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)

Visual-CFD 11.5 - Home Page

Applications File Edit View Model Tools Window Help

Standard New Ctrl + N Open Ctrl + O Open Project Append Alt + P Close Ctrl + F4 Close All Ctrl + Alt + F4 Save Ctrl + S Save As Ctrl + Shift + S Save Project Save Image/Movie/Report Ctrl + I Session Page Setup Preview Print Ctrl + P Preferences Alt + G

1 E.W. _#Tank.stl
2 E.W. _#5_Tank.vdb
3 simple_fullcar-20150206.stl
4 D:\models\wesi-sportscar.stl
5 E.W. _#triSurface#motorBike.obj
6 F.West01#wegr.vdb
7 F.West01#wegr.stl
8 F.West01#wegr.vdb
9 m28310-2m820_inmani-modi.stl

motorBike.vdb

motorBike

Model Options

Problem Type
Analysis Type External Flow

Time Dependence
Time Dependence Steady State

Physics
Heat Transfer
Multi Phase (VOF) ☒
Gravity ☒
Boussinesq ☐
Flow Type Turbulent ☒
Turbulence Models RAS Models ☒
RAS Models SST-k-Omega ☒
Gravity (m/s²)

File saved in VISUAL-ENVIRONMENT 11.5 from applica
Platform: Windows 64 Bit

Model box size
= (10.2141, 2.0

File E:\Openfoam\Tutorial-Visual-CFD\motorBike.vdb

Python 2.7.3 (default: Mar 17 2014, 17:44:20) [MSC v
>>> pagecreate()
>>> pagecreate()
>>> pagecreate()
>>> pagecreate()

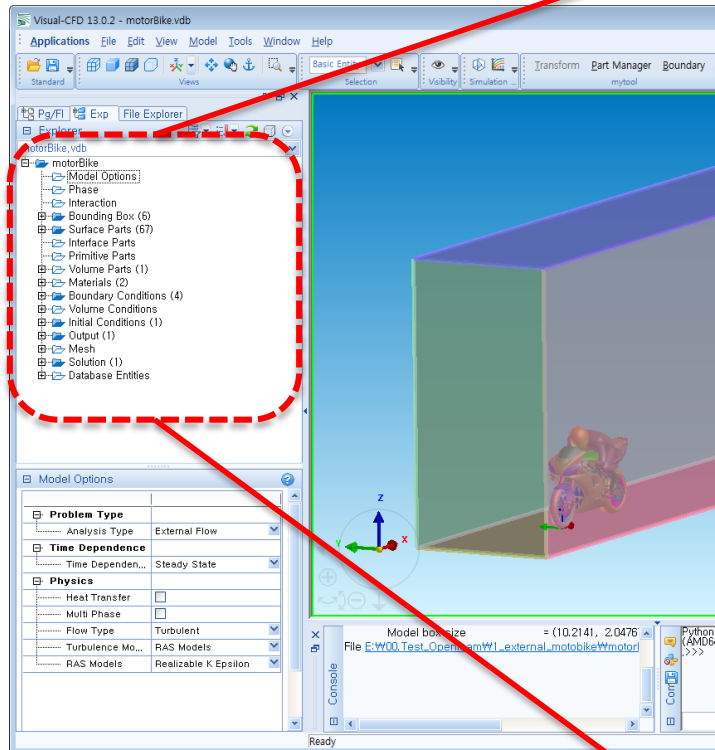
0
batchMode
constant
system
boundaryFileModificationInfo
injector-01.foam

Drag & Drop

OpenFOAM Directory Import

2. Visual-CFD 주요 기능

Model Setup Tree

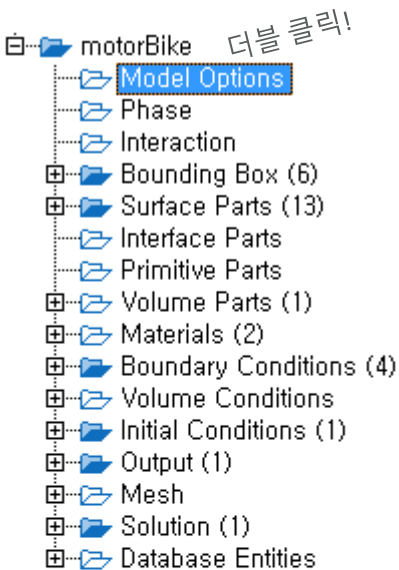


- motorBike
 - Model Options
 - Phase
 - Interaction
 - ⊕ Bounding Box (6)
 - ⊕ Surface Parts (67)
 - Interface Parts
 - Primitive Parts
 - ⊕ Volume Parts (1)
 - ⊕ Materials (2)
 - ⊕ Boundary Conditions (4)
 - ⊕ Volume Conditions
 - ⊕ Initial Conditions (1)
 - ⊕ Output (1)
 - ⊕ Mesh
 - ⊕ Solution (1)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

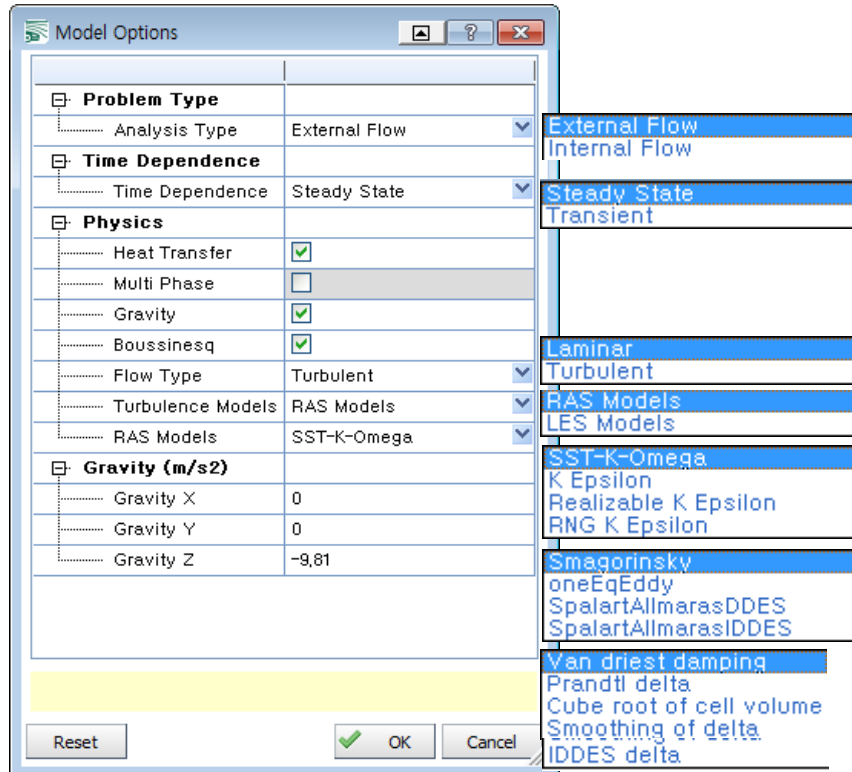
Top-Down
방식의
직관적인
모델 설정
구조

2. Visual-CFD 주요 기능

Model Options



- 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

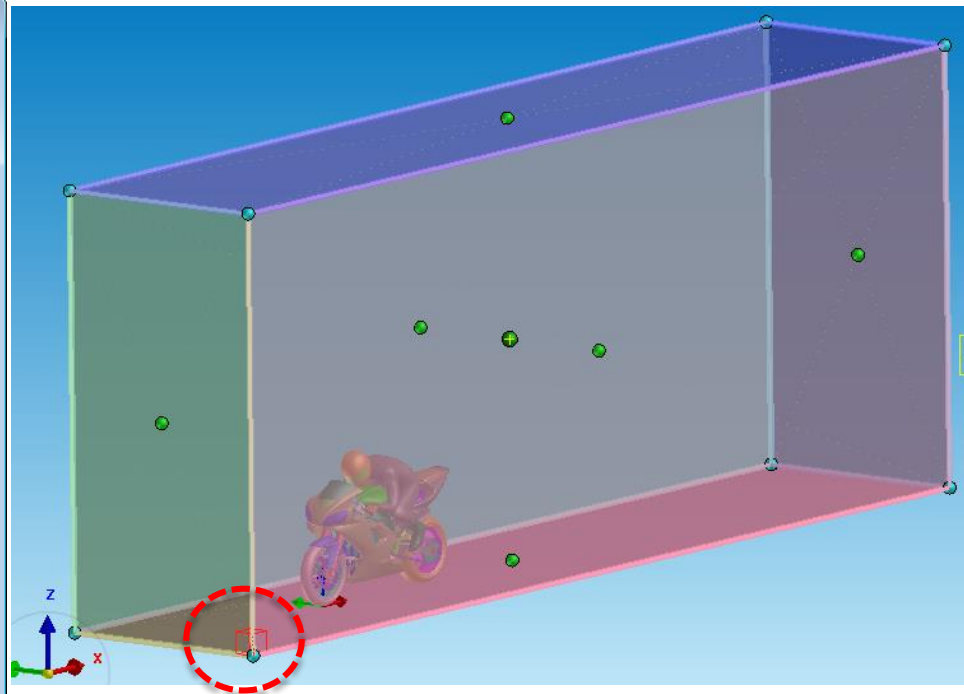
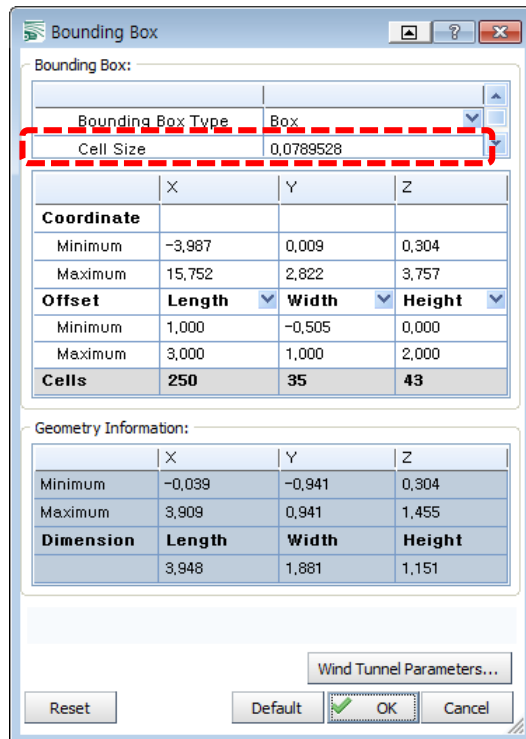
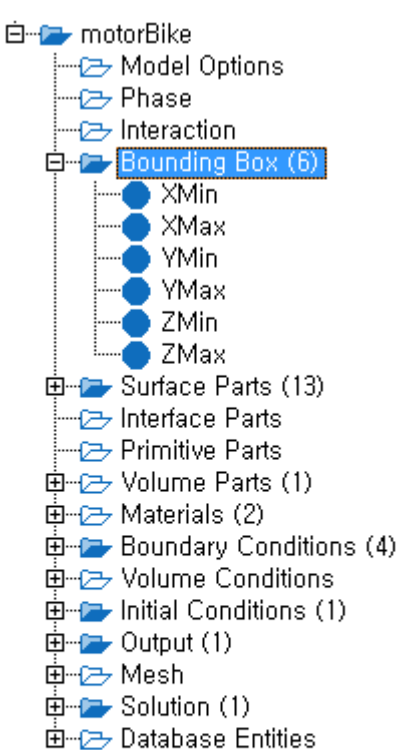
LIST OF OpenFOAM® SOLVERS SUPPORTED

simpleFoam
pimpleFoam
rhoSimpleFoam
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

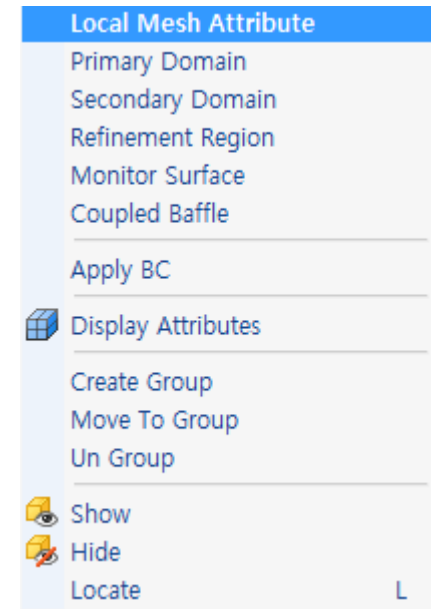
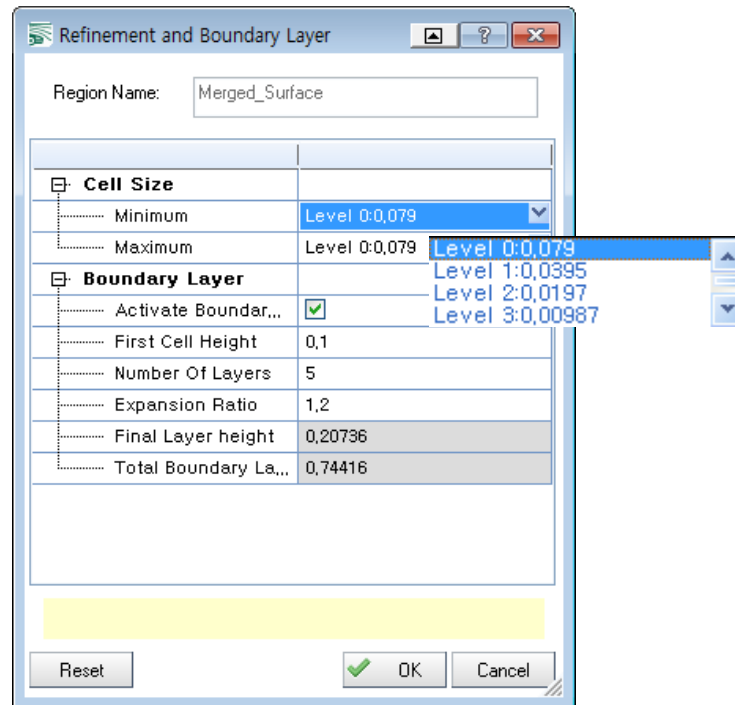
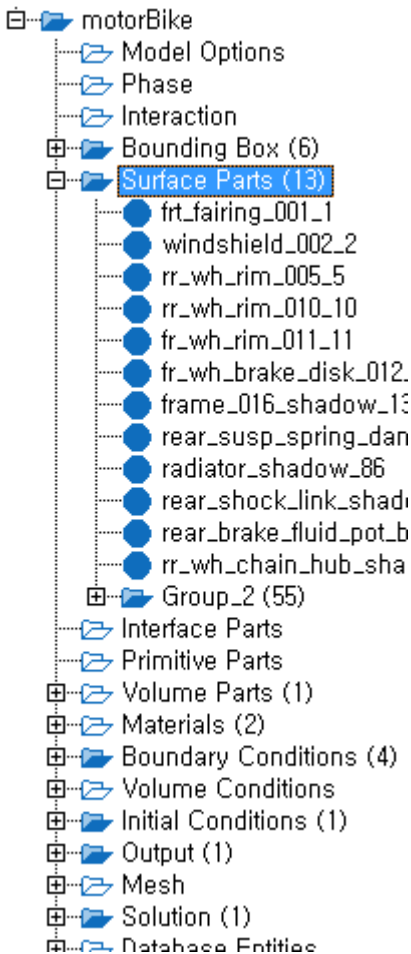


blockMesh 최대 격자 (level0)

2. Visual-CFD 주요 기능

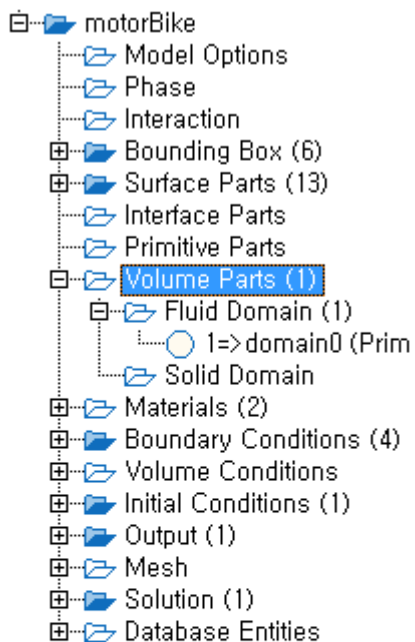
Surface Parts

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

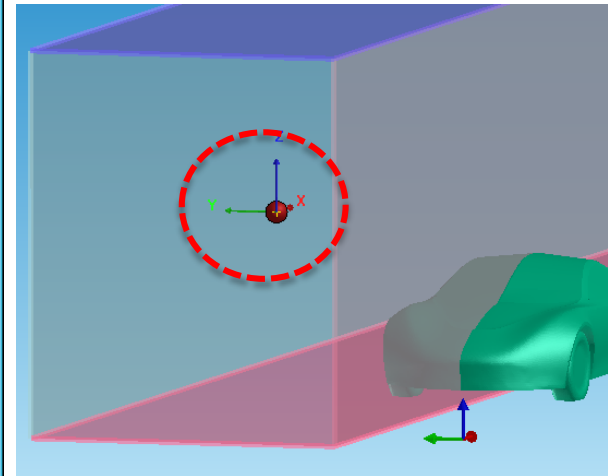
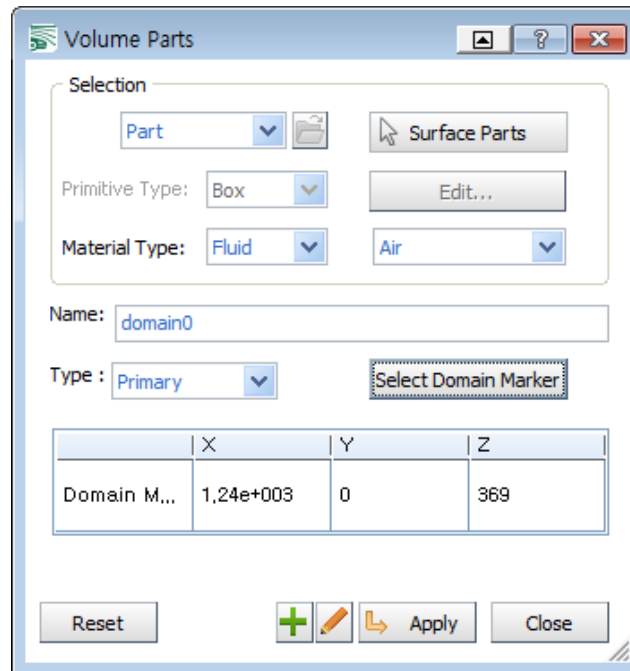


2. Visual-CFD 주요 기능

Volume Parts



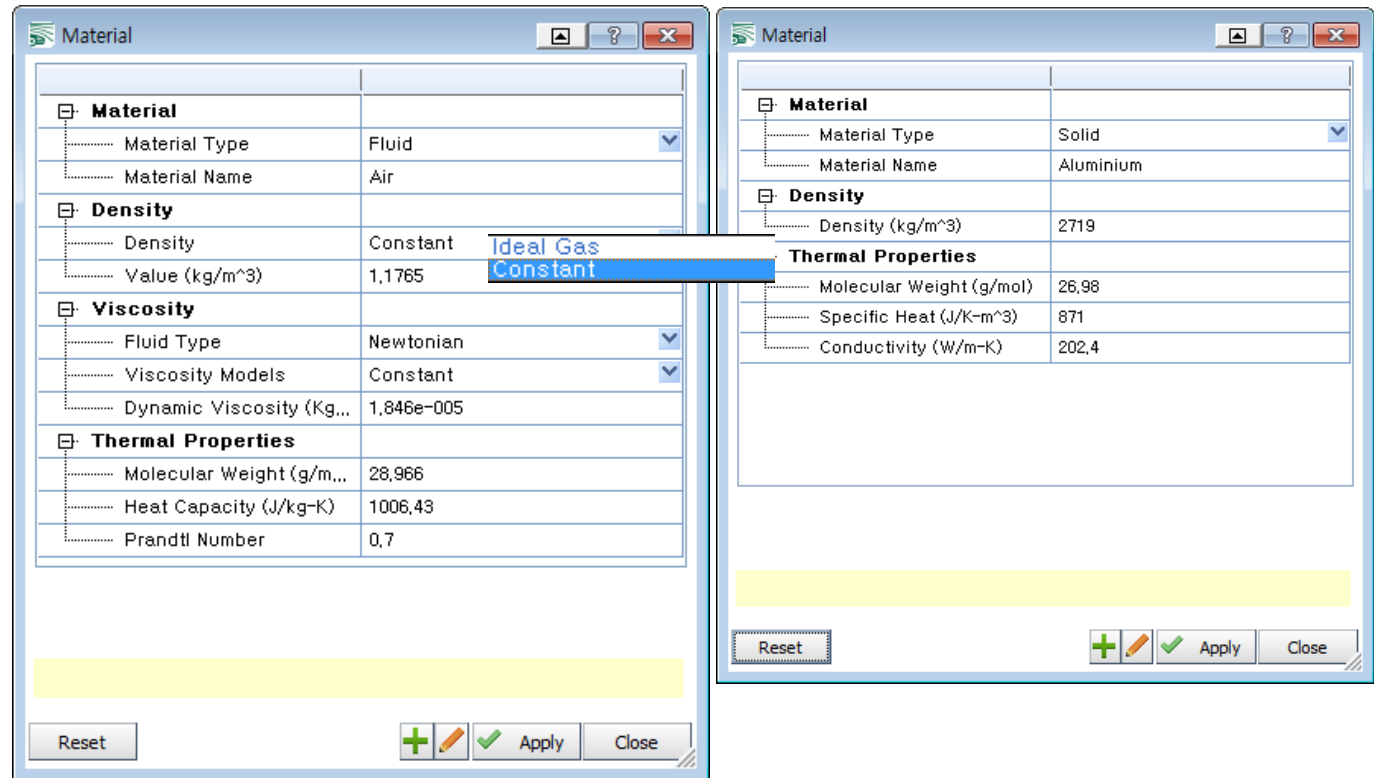
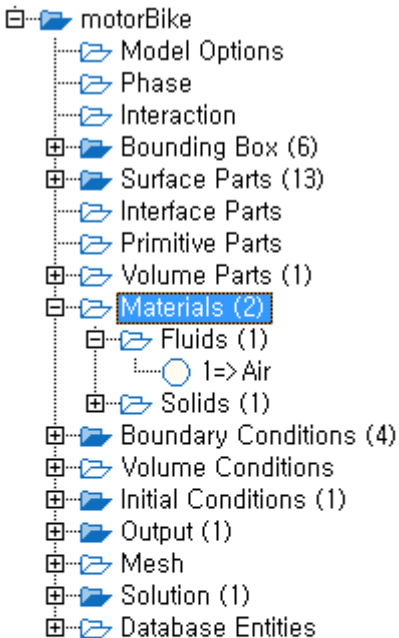
- 해석 영역(볼륨) 위치 정보 설정 (SnappyHexMesh의 "locationInMesh")
- 좌표 직접 입력 또는 화면상 마우스 드래그 가능
- 멀티도메인 및 유체/고체영역 설정
(ESI OpenFOAM+ 사용 시 각 도메인 내부 포인트만 입력)



2. Visual-CFD 주요 기능

Material Properties

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



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

The screenshot illustrates the process of assigning boundary conditions in ESI Visual-CFD. On the left, the software's tree view shows a project named 'motorBike' with various components like 'Model Options', 'Phase', 'Interaction', 'Bounding Box (6)', 'Surface Parts (13)', 'Interface Parts', 'Primitive Parts', 'Volume Parts (1)', 'Materials (2)', and 'Boundary Conditions (4)'. The 'Boundary Conditions' folder is expanded, showing four items: '1=> Wall', '2=> Inlet', '3=> Outlet', and '4=> Symmetry'. The main window displays the 'Boundary Conditions' dialog box, which has a 'Selection' dropdown set to 'Surface Parts'. Below this, a table lists the BC types and their corresponding values:

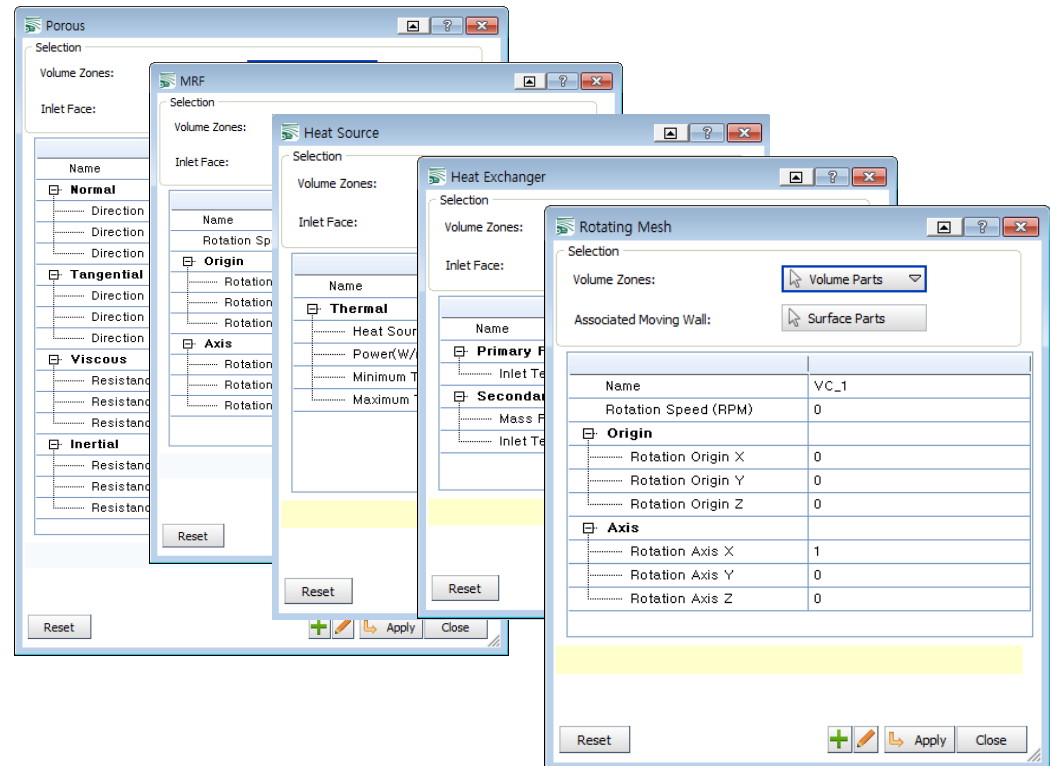
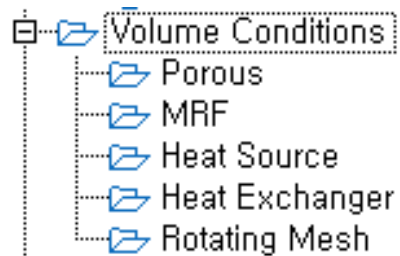
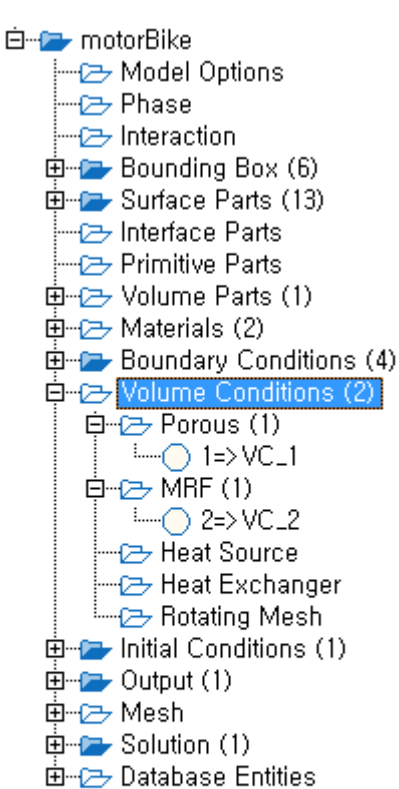
BC Types	
Inlet Types	Velocity
Velocity (m/s)	Normal Velocity
Normal Velocity	1
Turbulence Parameters	Turbulence Intensity and L...
Turbulent Intensity (%)	10
Length Scale (m)	1
Temperature (K)	300

Below the table, there are buttons for 'Velocity', 'Pressure', 'Mass Flow', 'Pressure', and 'Outflow'. A red arrow points from the 'hx_fan_blade' part in the tree view to the 'Assign BC' dialog box, which lists the assigned BCs: 'Wall', 'Inlet', 'Outlet', 'Symmetry', and 'Create New BC'. The 'Assign BC' dialog box also has 'OK' and 'Cancel' buttons.

2. Visual-CFD 주요 기능

Volume Conditions

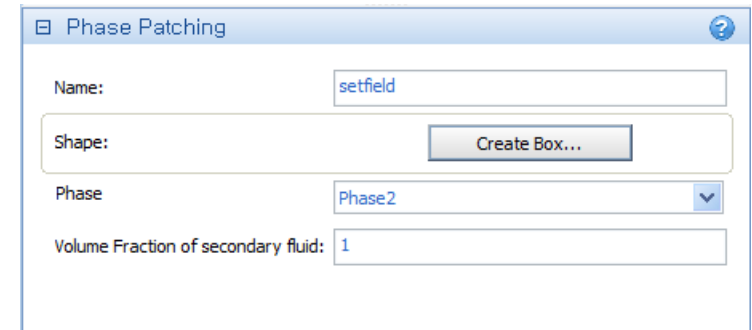
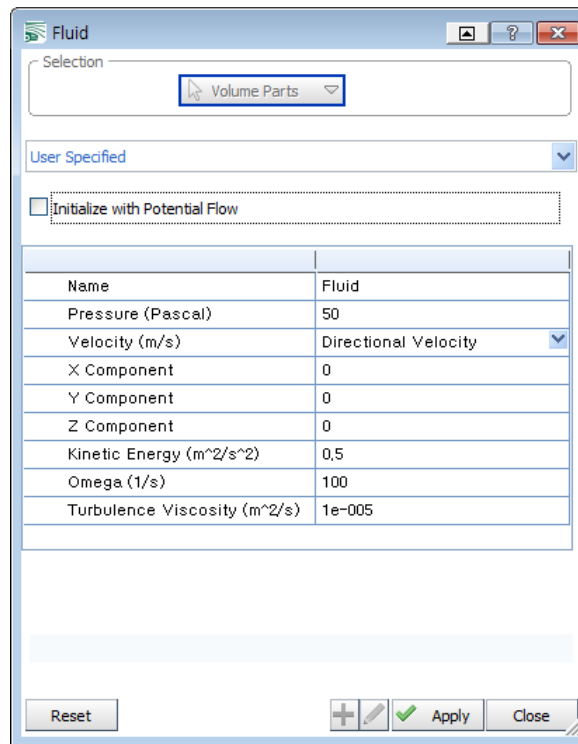
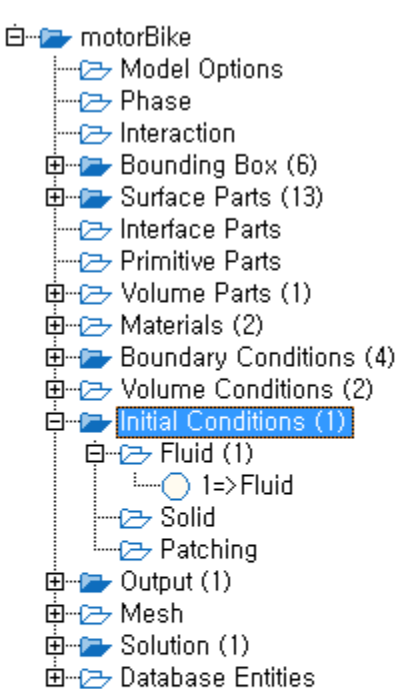
- 5가지 볼륨 조건 설정 가능
- 특정 파트의 center, axis 를 화면상의 노드 클릭으로 계산 가능
- Rotating Mesh는 Moving 영역 및 파트 설정 필요



2. Visual-CFD 주요 기능

Initial Conditions

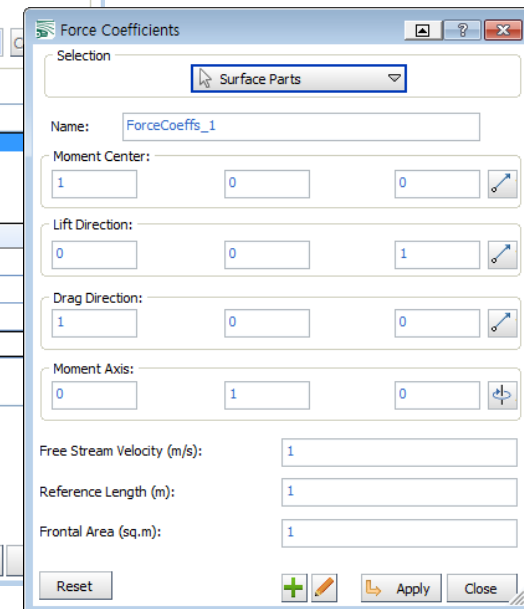
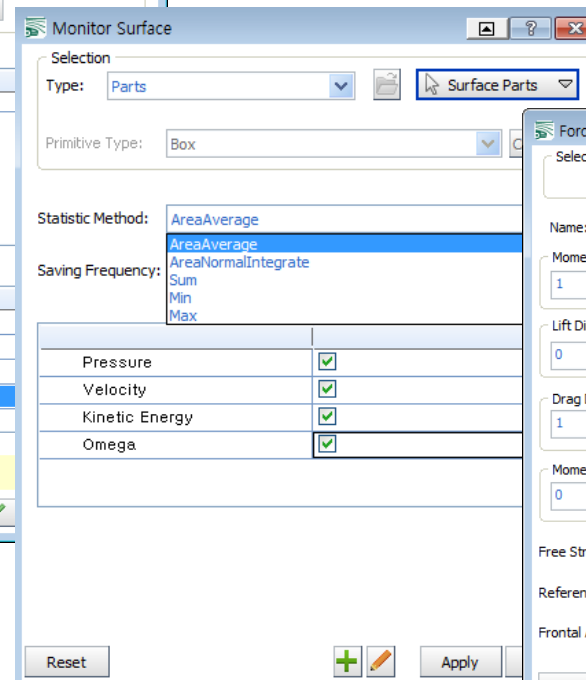
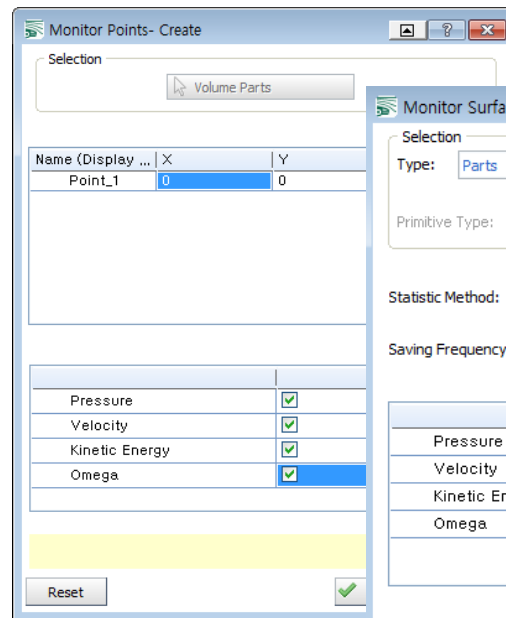
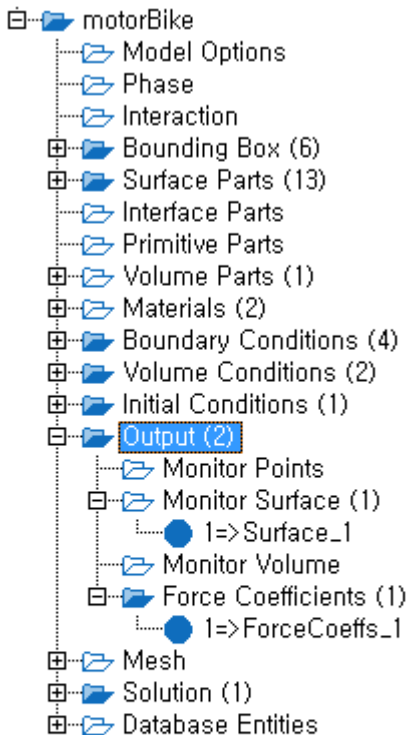
- 유동장 초기값 설정
- potentialFoam 실행 여부 설정
- VOF 적용 시 초기 VOF 영역 설정 (box)



2. Visual-CFD 주요 기능

Output

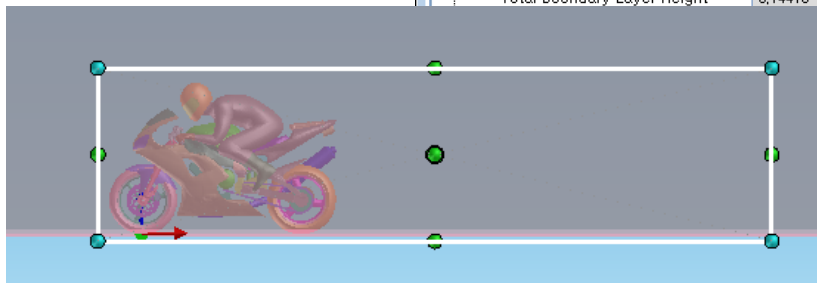
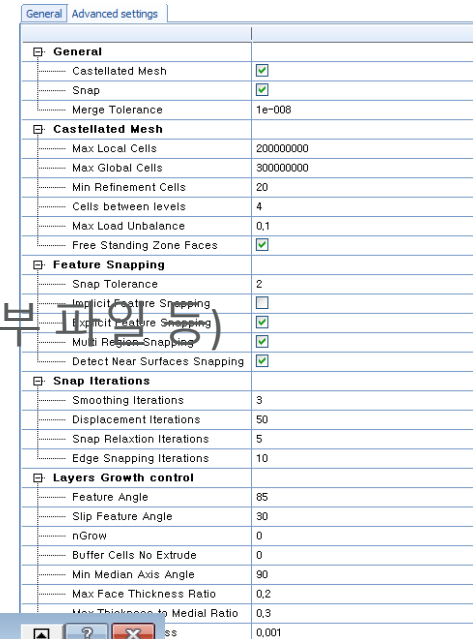
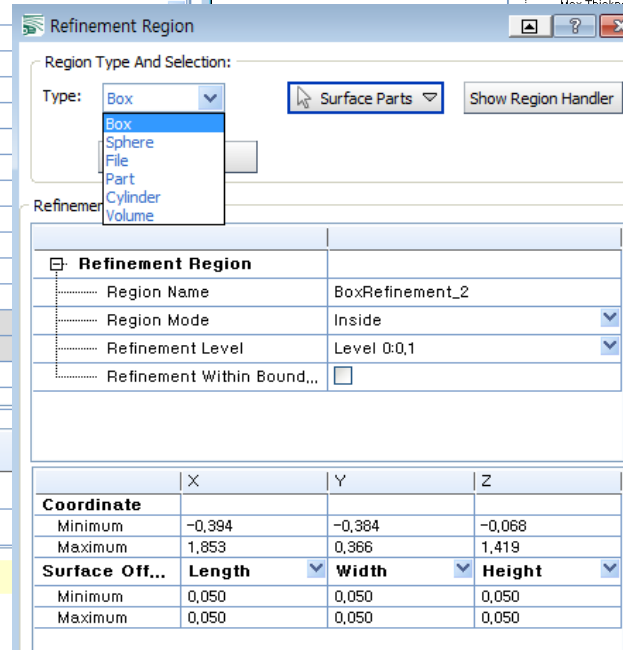
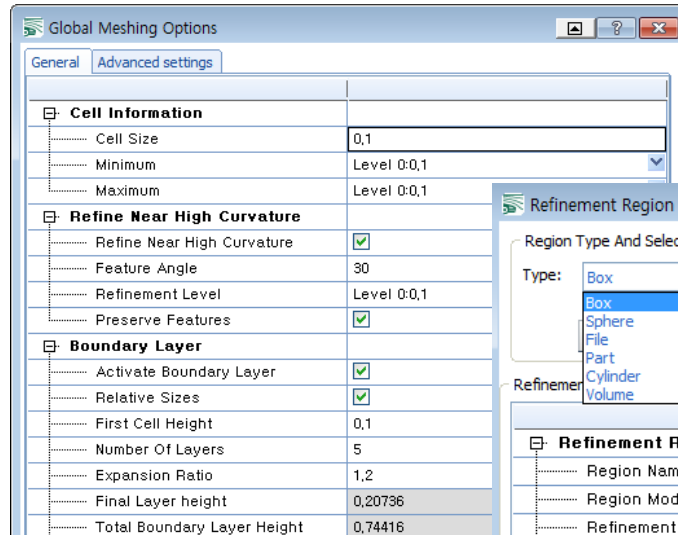
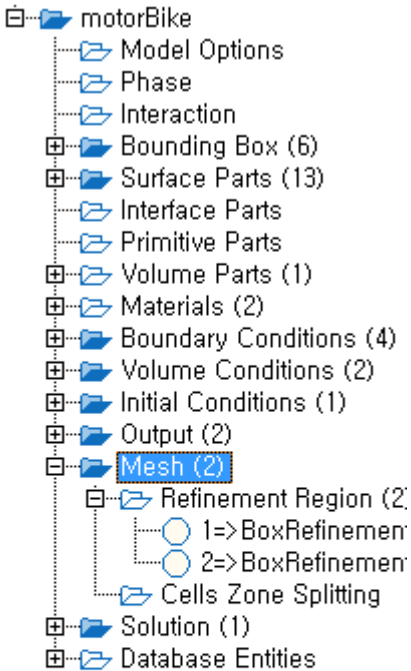
- 해석 시 특정 유동장 값 출력을 위한 옵션 설정 (모니터링)
- 포인트, 면, 볼륨에 대한 다양한 변수값 계산 기능 설정 가능
- 기본 변수 외 가공된 값 계산 설정 가능 (현재 항력계수 설정 제공)



2. Visual-CFD 주요 기능

Volume Mesh

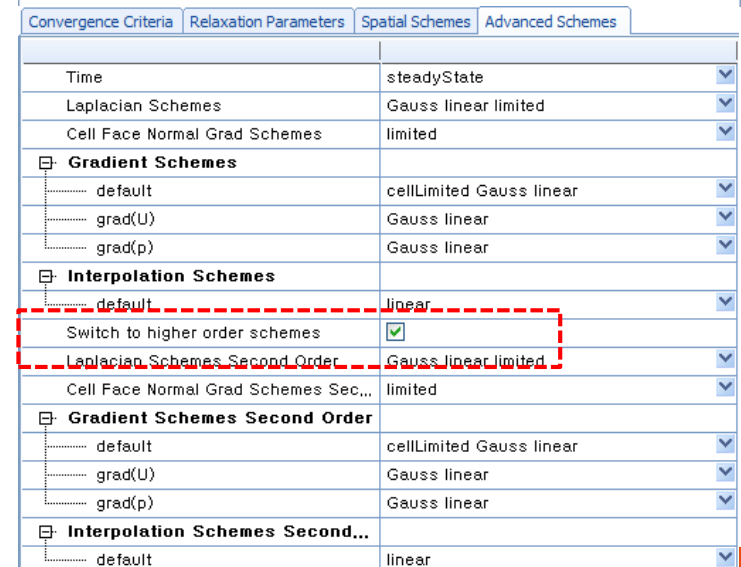
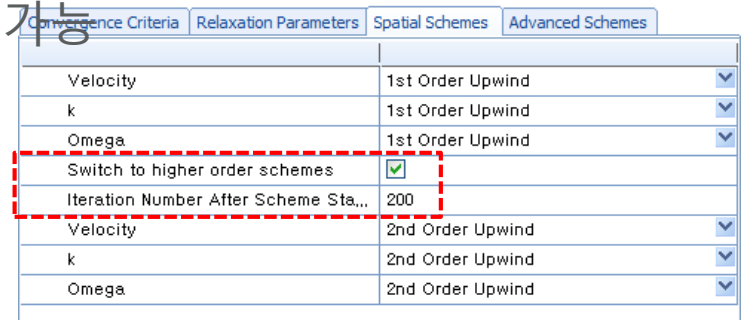
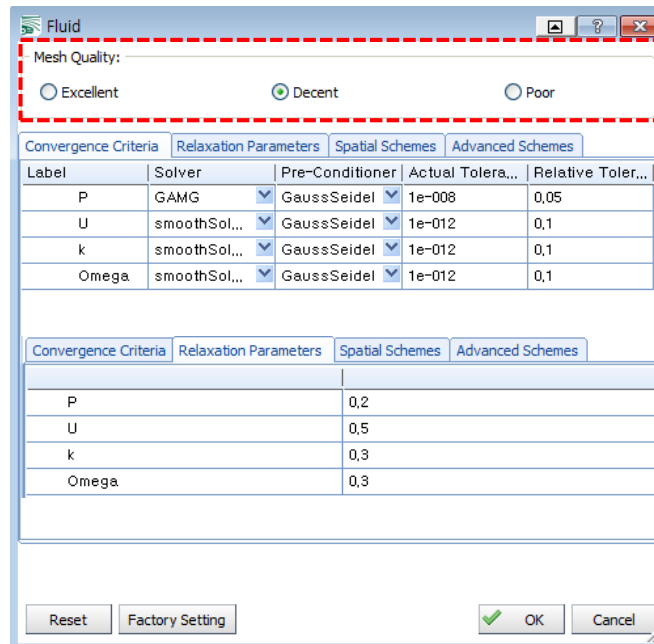
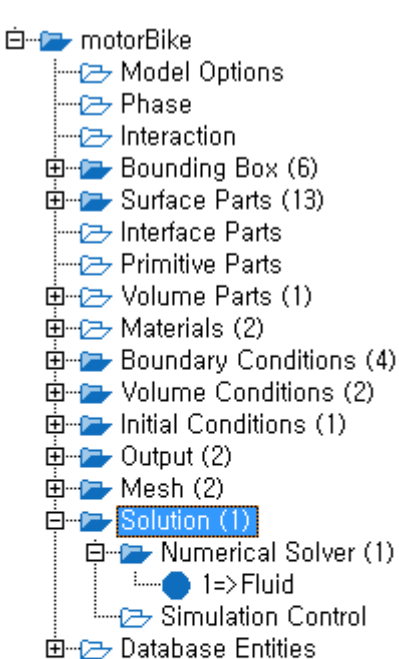
- 글로벌 격자 조건 설정
- 격자 Refine 영역 설정 (box, cylinder, sphere, 외부 파일 등)
- snappHexMesh의 세부 옵션 설정



2. Visual-CFD 주요 기능

Numerical Solver

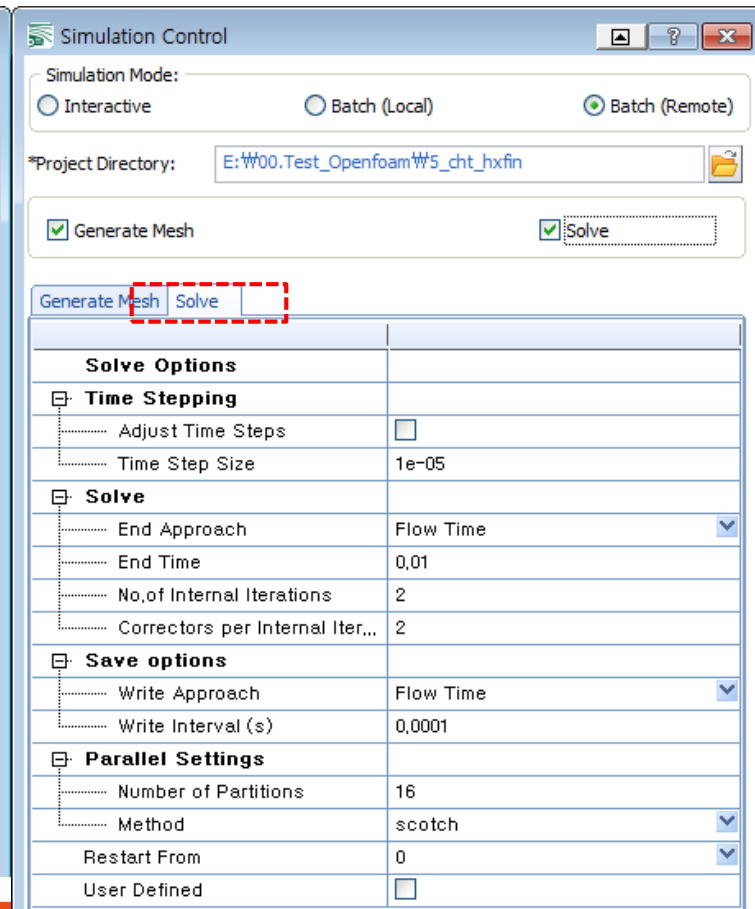
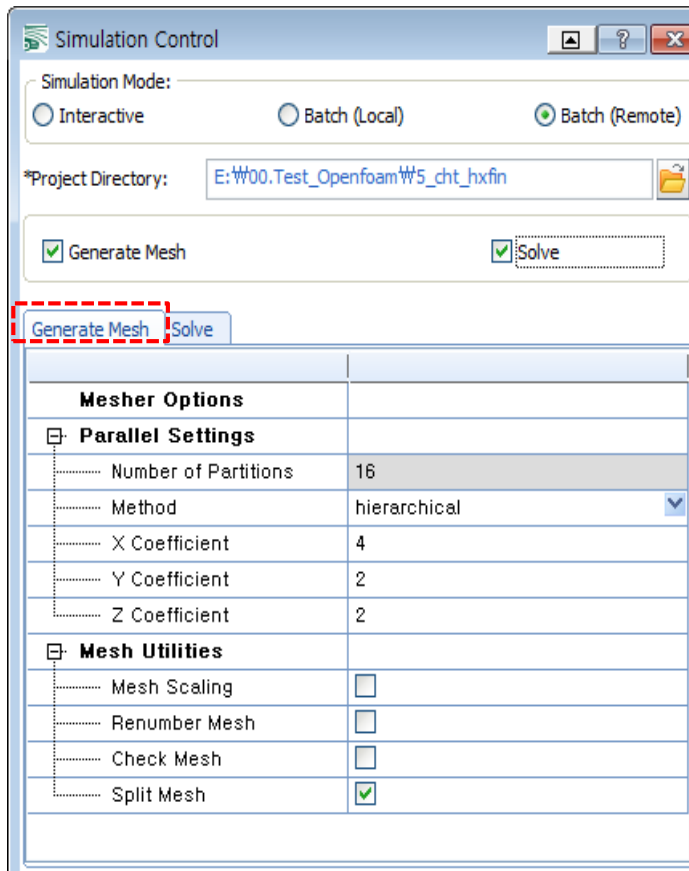
- 변수 별 수렴도, 완화계수, 이산화 기법 등 선택 가능
- 격자 수준에 따라 기본 설정 사용 가능
- 특정 iteration 후 적용 기법 변경 가능



2. Visual-CFD 주요 기능

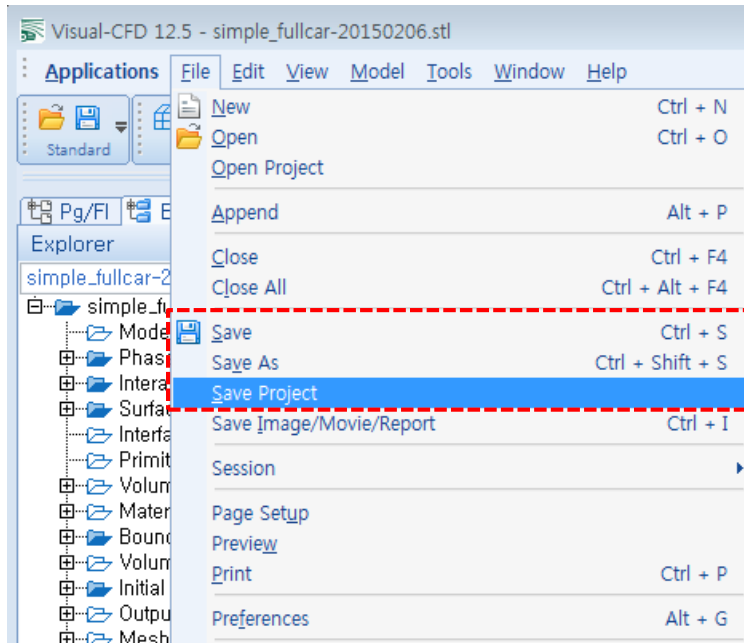
Simulation Control

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

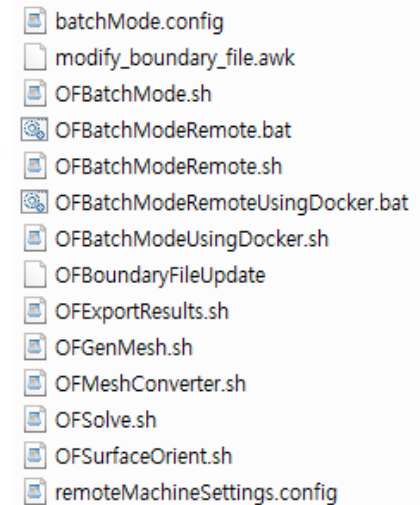
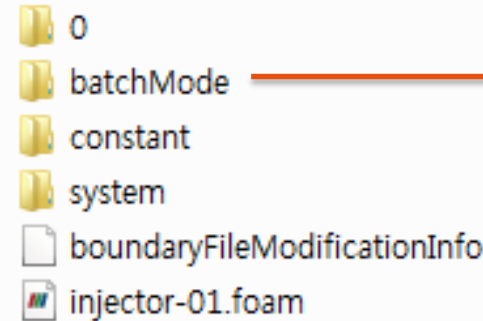
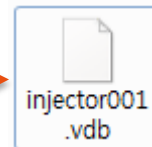


2. Visual-CFD 주요 기능

Save



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

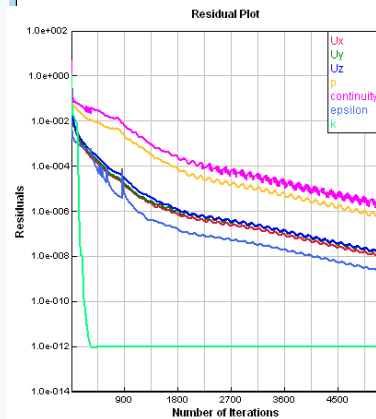
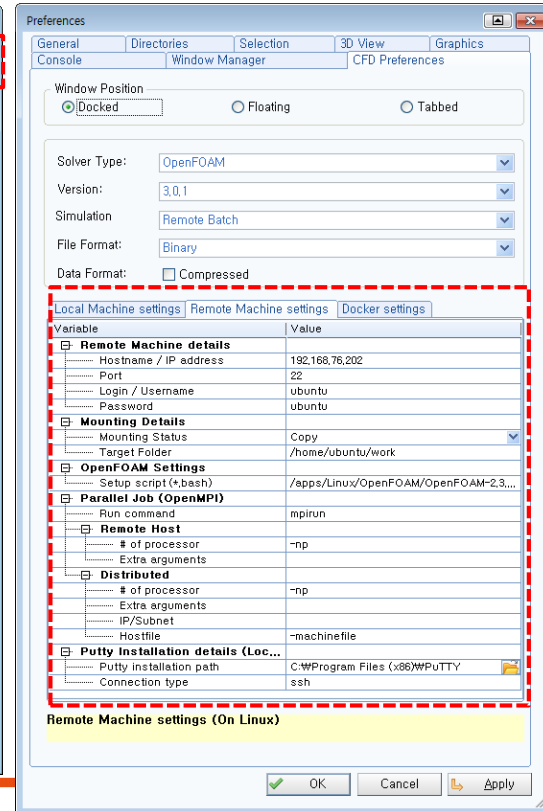
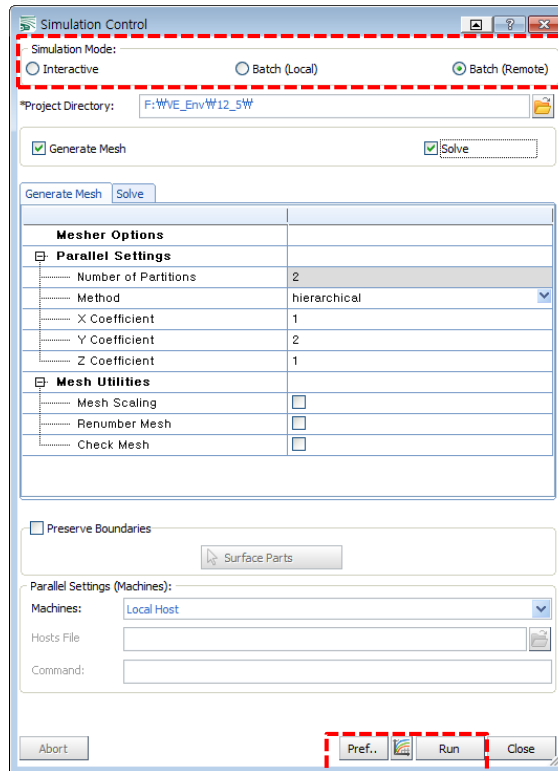


2. Visual-CFD 주요 기능

Run



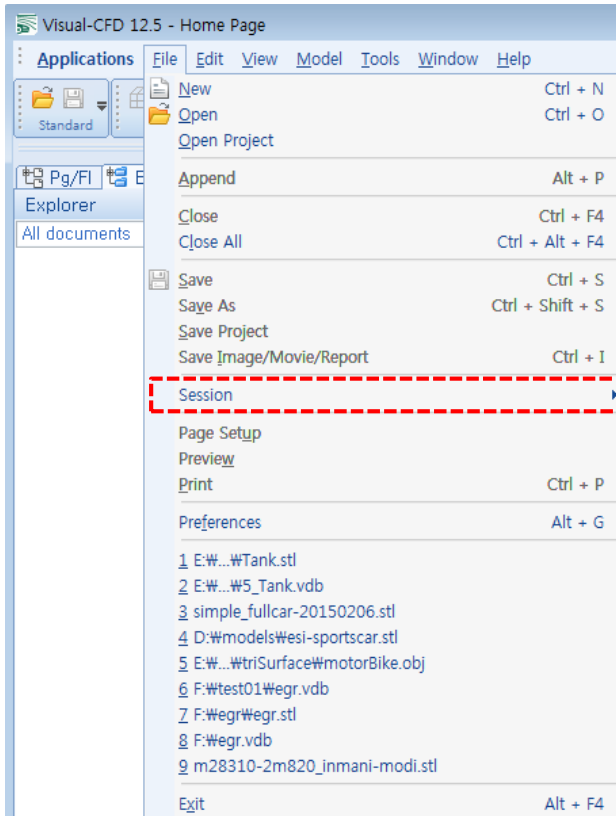
- 솔버 실행 방법 선택 (로컬 장비, 원격 장비, 독커 등)
- 매쉬 작성 및 솔버 선택적 실행
- 매쉬 및 솔버 실행 파라미터 설정 및 기타 유틸리티 실행여부 설정
- 솔버 수렴성 및 모니터링 값 Plot



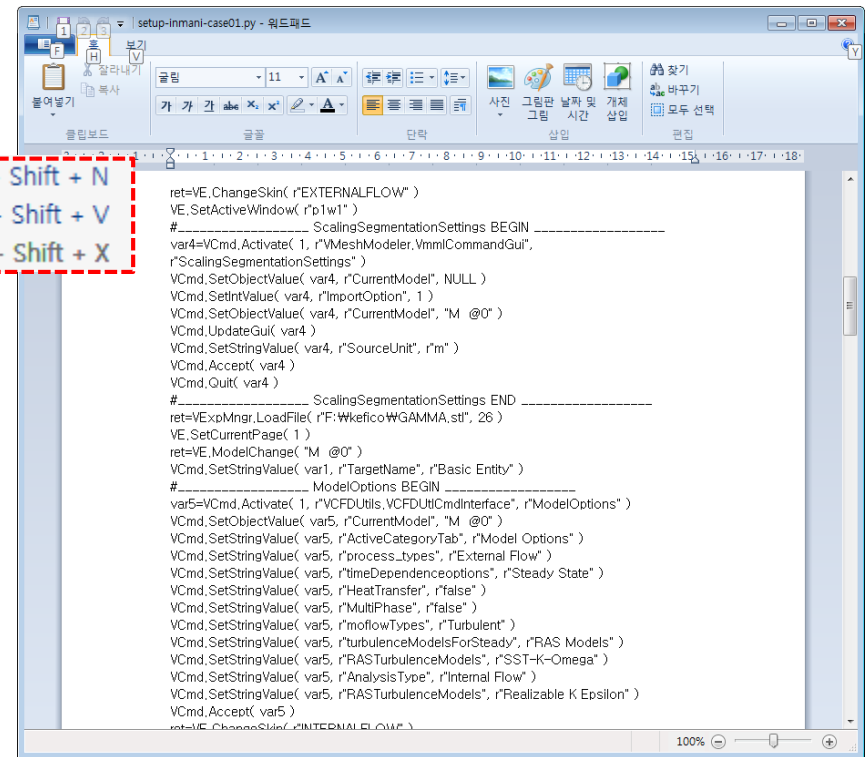
2. Visual-CFD 주요 기능

Macro Recording (Session)

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

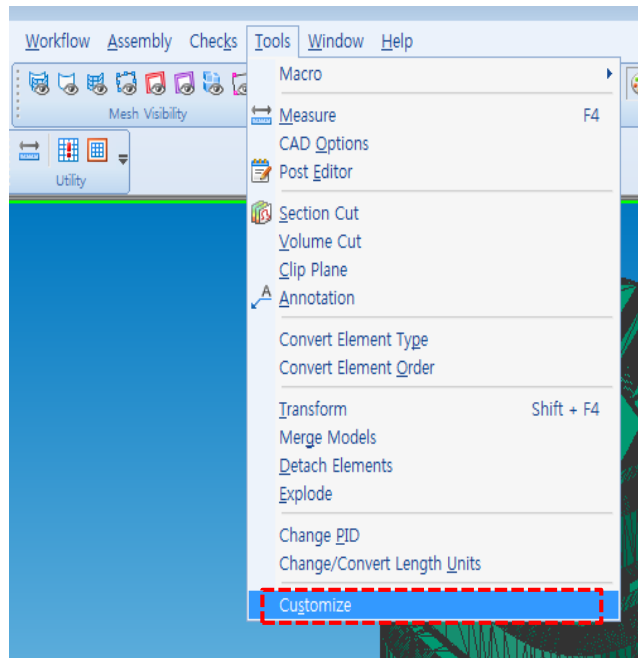


Start New	Ctrl + Shift + N
Save	Ctrl + Shift + V
Execute	Ctrl + Shift + X

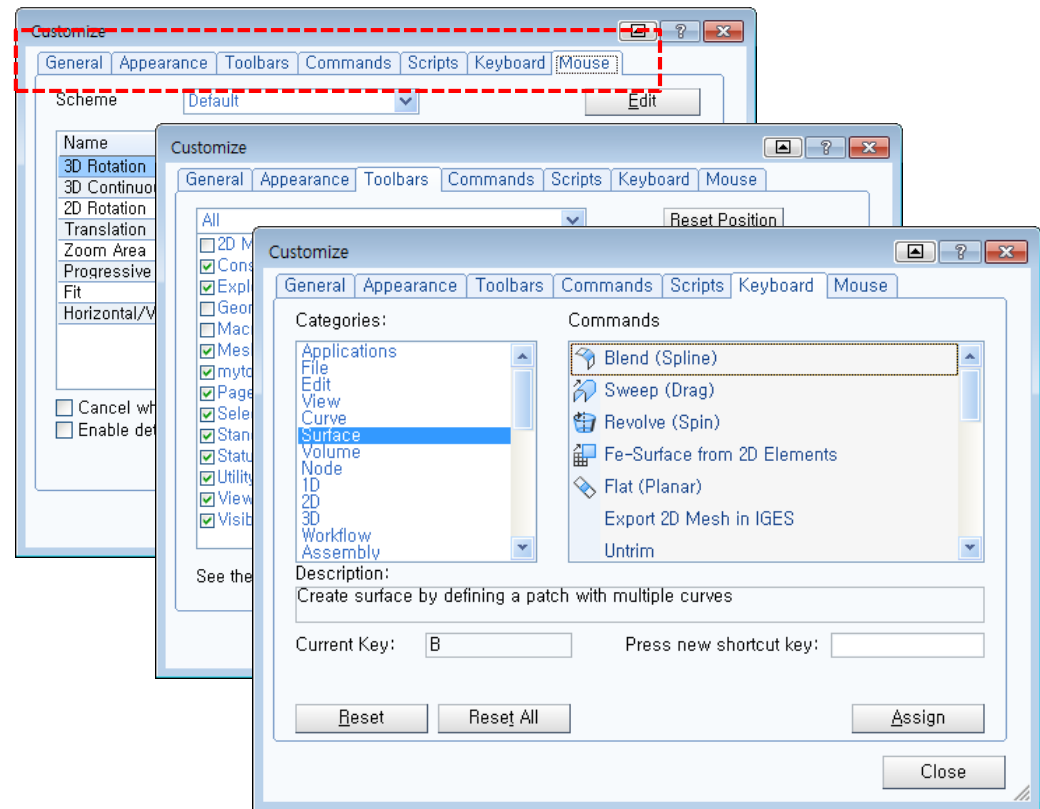


2. Visual-CFD 주요 기능

User Customization

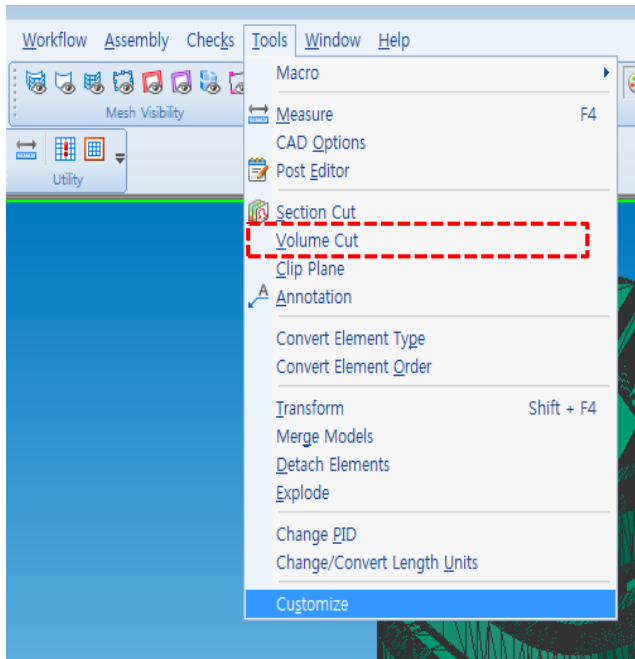


- GUI의 다양한 기능을 사용자 설정하여 사용 가능
- 대화창, 툴바, 단축아이콘, 단축키, 마우스 등

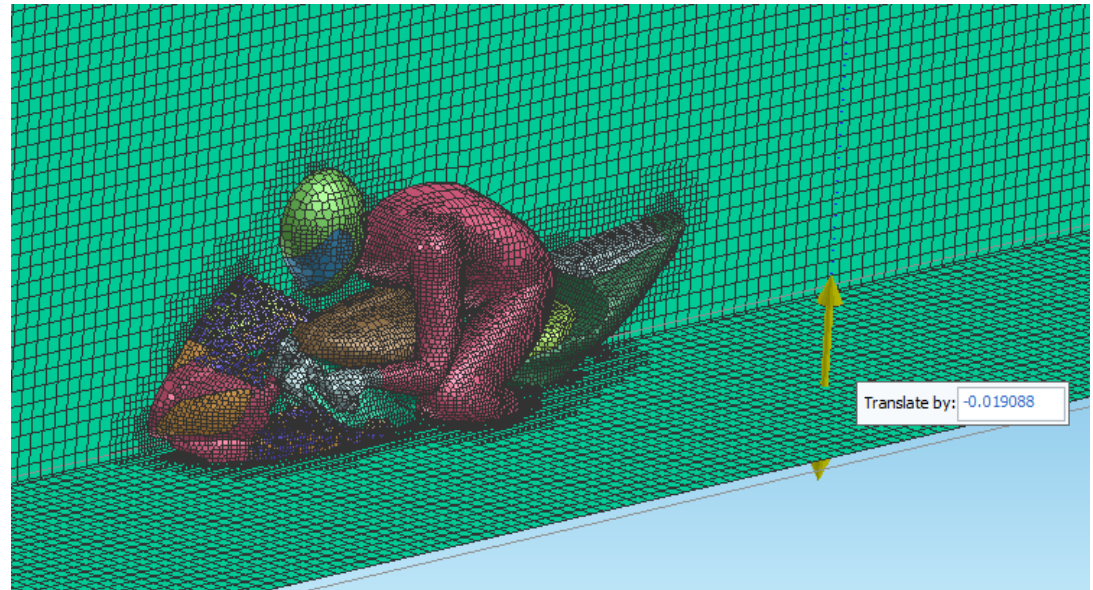


2. Visual-CFD 주요 기능

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

사용자 정의
Process

```
graph TD; A[Create Project] --> B{User Inputs}; B --> C[Advance Inputs]; C --> D[Mesh]; D --> E[Simulation]; E --> F[PostProcessing];
```

해석 모델
입력창

Create Project

Enter Case name: test_case

Working Directory: C:\Users\lesipune\visual

Select Geometry File: Browse

OK

해석 조건
입력창

Basic User Inputs

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

If Yaw Angle is "0" then a symmetric model is prepared

Mesh Settings

Surface Size on Ship body: 16m 2nd scale 0.25m

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

Run Options

Submit on Cluster: ☐

Parallel Run: ☒

No of Partitions: 2

Total Time: 50 sec

Save Data at: 0.05 sec

Advance Controls: ☐

Save Input

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

Parts = 3

Model box size = (6.27559, 0.858505, 0.572322) Diagonal length =

File C:\Users\lesipune\FILES\DTC_in_m.stl loaded

Please update your graphic card to benefit from our optimized rendering

3. Visual-Process (SDK)

해석 자동화 프로세스 작성 툴

The screenshot displays the Visual-SDK (Execute Process Builder) 11.5 - NewTemplate interface. The main workspace shows a process flow diagram with blocks: NormalBlock, Sub Process, Decision (Left/Right), Sub P, and Normal. A red callout bubble points to the Block Library on the left, stating: "ESI의 통합 인터페이스 Visual-Environment 환경". Another red callout bubble points to the process flow, stating: "Drag & Drop, 마우스 클릭으로 만드는 직관적인 사용자 Process". A third red callout bubble points to the NormalBlock Settings window, stating: "사용자만의 변수 추가/사용". A fourth red callout bubble points to the NormalBlock Settings window, stating: "사용자만의 추가 GUI 작성 기능". A fifth red callout bubble points to the NormalBlock Settings window, stating: "모든 기능에 대한 Python 스크립트 지원". The NormalBlock Settings window shows the General tab with fields for Name, Label, Tool Tip, Description, Image File, Script Type (PYTHON), Help Topic, Interface, Command, and Method. The Location & Dimension tab shows Location X, Location Y, Height, and Width. The Ports tab shows a table with # and Port columns. The GUI tab shows a preview of the NormalBlock with a Button. The Script tab shows the Python script for the NormalBlock.

ESI의 통합 인터페이스
Visual-Environment 환경

Drag & Drop, 마우스
클릭으로 만드는
직관적인 사용자 Process

사용자만의 변수
추가/사용

사용자만의 추가
GUI 작성 기능

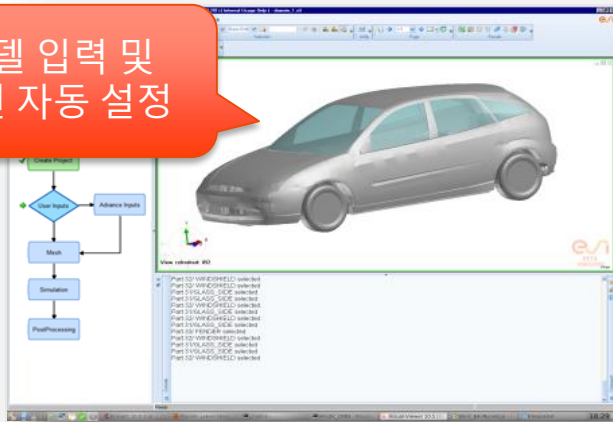
모든 기능에 대한
Python 스크립트 지원

```
1 # -*- coding: UTF-8 -*-
2
3 File Name: NormalBlock.py
4 Module Information: NormalBlock Generated by Visual-Process
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
```

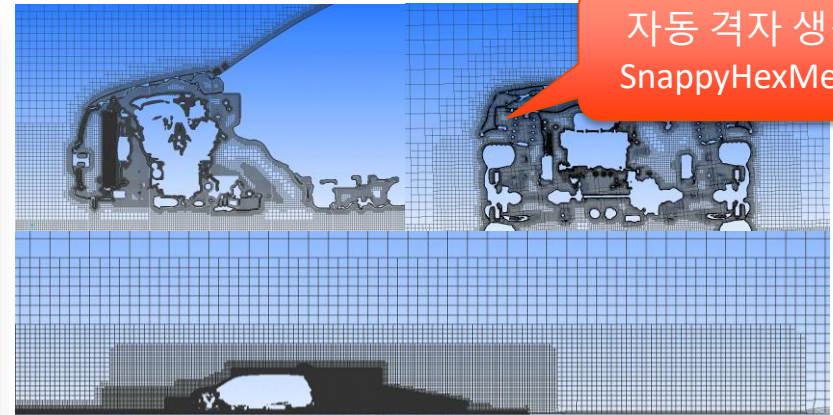
3. Visual-Process (SDK)

Visual-Process를 이용한 OpenFOAM 해석 자동화 사례

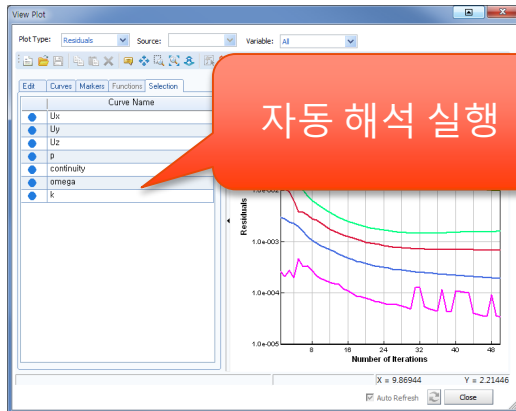
해석 모델 입력 및
해석 조건 자동 설정



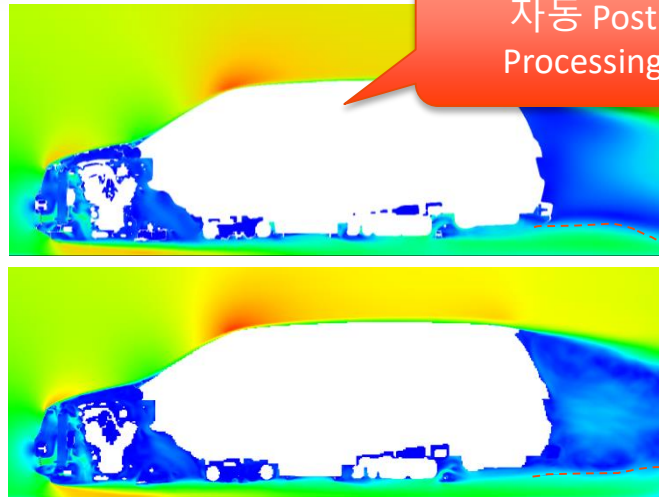
자동 격자 생성
SnappyHexMesh



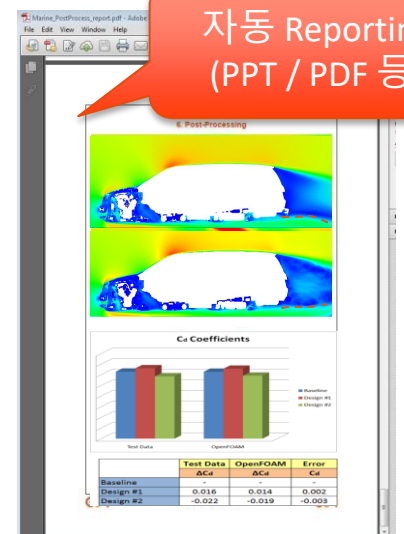
자동 해석 실행



자동 Post
Processing



자동 Reporting
(PPT / PDF 등)





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