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IDAJ CAE Solution Conference

Fluent Meshing介绍及复杂模型建模

2016.11.23 北京艾维克酒店

IDAJ-China 北京技术部

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- ANSYS Meshing产品线综述
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  - Fluent Meshing定位
- Fluent Meshing功能介绍及竞争优势
  - 功能介绍
  - 特色功能
    - ✓脚本化执行
    - ✓ACT 定制包面（插件）
- 总结及致谢

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ANSYS Meshing 产品线综述

CFD 网格可以分为5个类别

	Class 1	Class 2	Class 3	Class 4	Class 5
几何形状破损度	Very High	High	Low	Medium	Medium
几何形状复杂性（部件或体数量）	> 1,000	100 ~ 1,000	≈ 100	> 100 parts	< 1,000
典型应用	Automotive & Aerospace UTM	Any	Any	Any	Aerospace, Turbo, Chemical & Material Proc.
用户需要：	• 高级同时高度自动化的CAD清理工具 • 快速生成大规模网格 • 可以修改网格	• 自动化的CAD清理 • 网格生成自动化 • 快速网格生成 • 非结构化网格	• 自动化/快速的求解 • Tet/prism网格类型	• 自动化/快速的求解 • 六面体为主的网格类型	• 可以修改网格 • 高质量六面体网格类型

ANSYS Meshing 产品线综述

	Class 1	Class 2	Class 3	Class 4	Class 5
几何形状破损度	Very Hi		Low	Medium	Medium
几何形状复杂性（部件或体数量）	> 1,0			100 parts	< 1,000
典型应用	Automotive & Aerospace UTM	Any			rospace, o, Chemical Material Proc.

ANSYS 的网格工具可以完整覆盖所有需求！

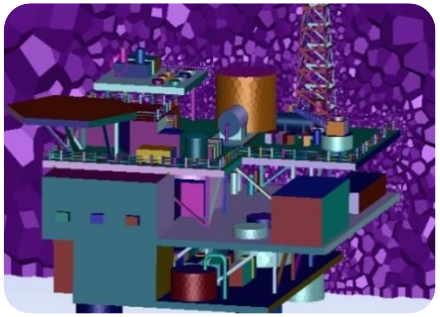
Fluent Meshing

ICEM CFD

Workbench Meshing

SCDM 可以为Class 1到Class 3准备几何!

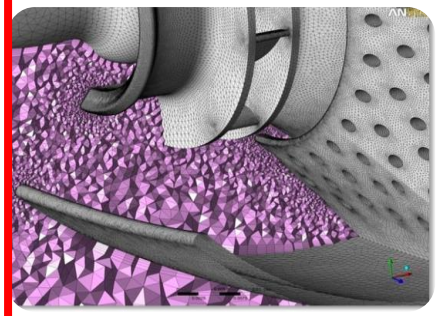
ANSYS Meshing 产品线综述 @ R17



Fluent Meshing

- 高级非结构化网格生成器 (Tet, HexCore, CutCell, Poly以及 Prisms) 专门用于处理复杂几何装配体

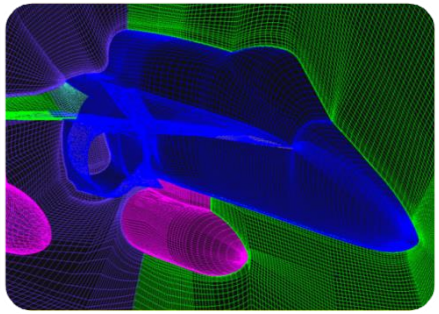
CFD



WB Meshing

- 通用型网格工具用于多物理场分析模型建模
- Workbench自带

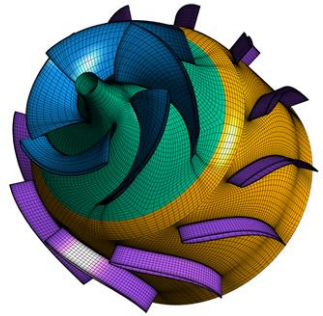
Multiphysics



ICEM CFD

- 高级六面体网格工具

CFD & Mechanical



TurboGrid

- 旋转机械行业专用六面体网格工具

CFD

Integrated in WB / Shared Libraries

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  - 功能介绍
  - 特色功能
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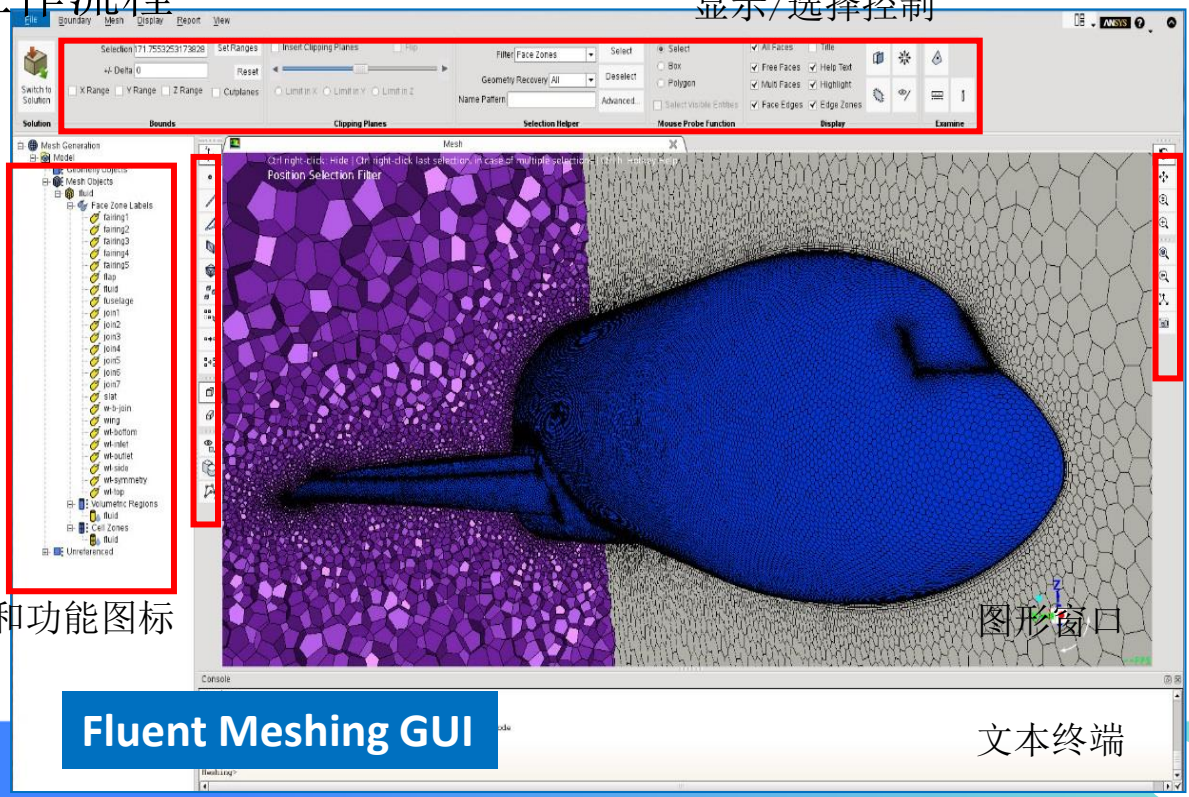
Fluent Meshing功能介绍及竞争优势

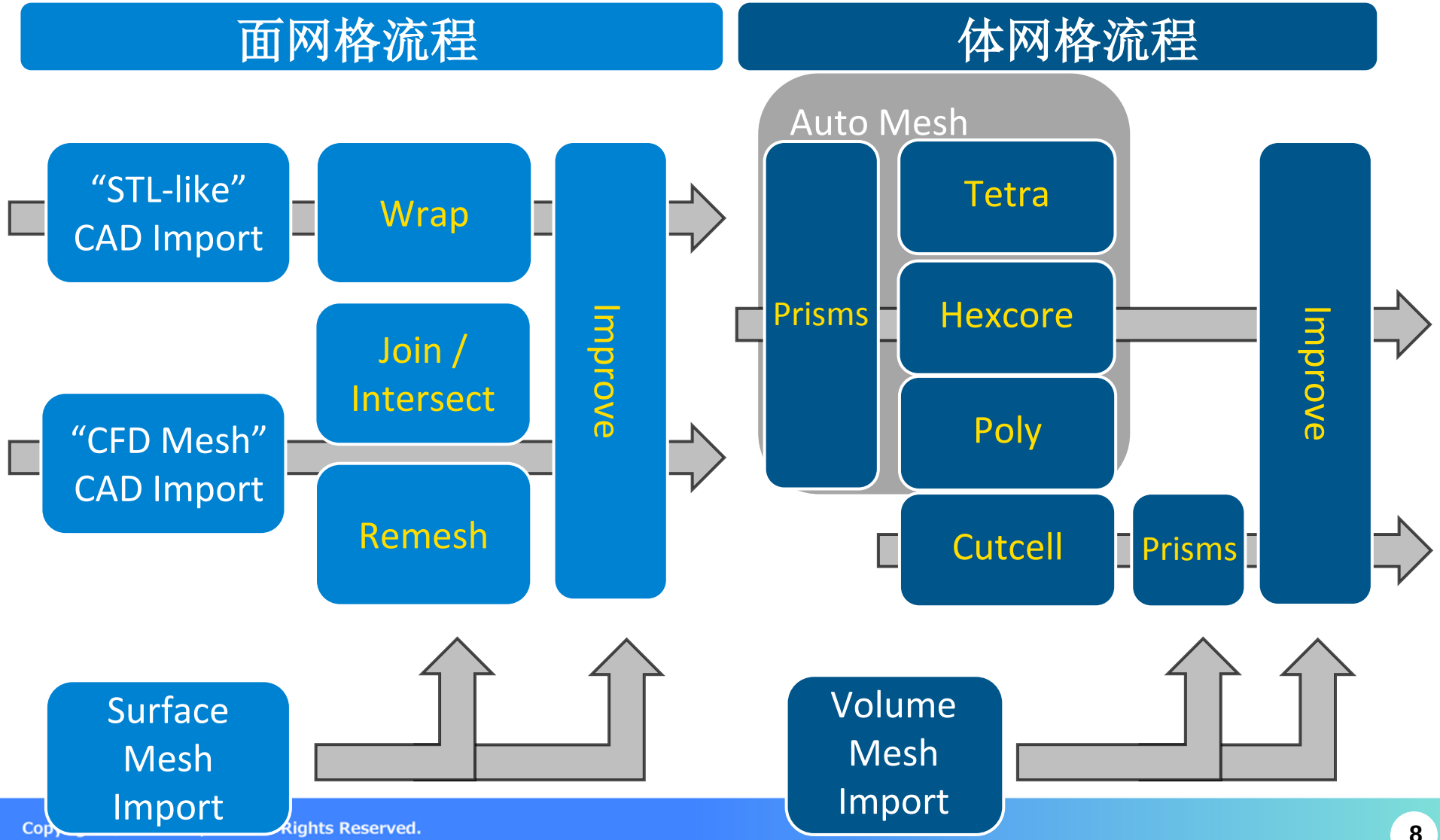
Fluent Meshing – 高级非结构化网格工具

- 嵌入**Fluent Solver GUI**
- 基于**Tgrid**网格算法
- 完整从**CAD**到**体网格**的工作流程
- **树形图**流程
- 可处理**超过十亿**体网格
- 支持**脚本化**批处理执行



Fluent Meshing功能介绍及竞争优势

工作流程



Fluent Meshing功能介绍及竞争优势

CAD导入及管理

Geometry

- **Native CAD formats**
  - Uses Workbench CAD readers
- **Neutral CAD Formats**
  - STEP, IGES, ACIS, Parasolid
- **ANSYS CAD Formats**
  - Space Claim, Design Modeler, Icem CFD, Gambit

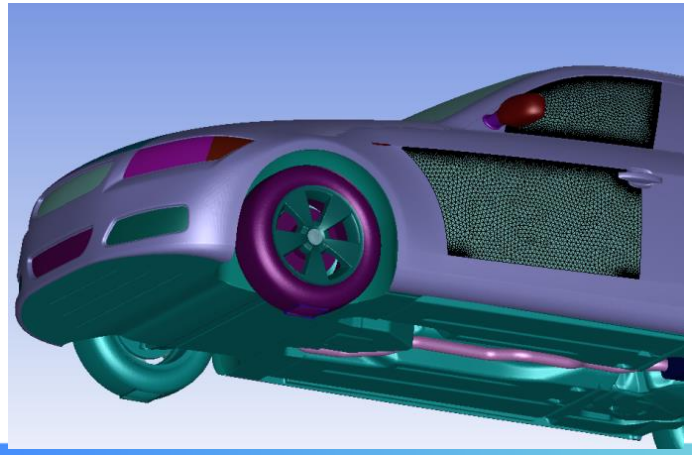
CAD以小离散面(faceted)形式被导入

CATIA SolidWorks NX Solid Edge creo parametric Autodesk Inventor Suite JT Open

- **Faceted geometries**
  - STL files

Mesh

- 多种网格格式
  - MSH, CGNS, PATRAN, NASTRAN
  - Surface 与/或 volume mesh

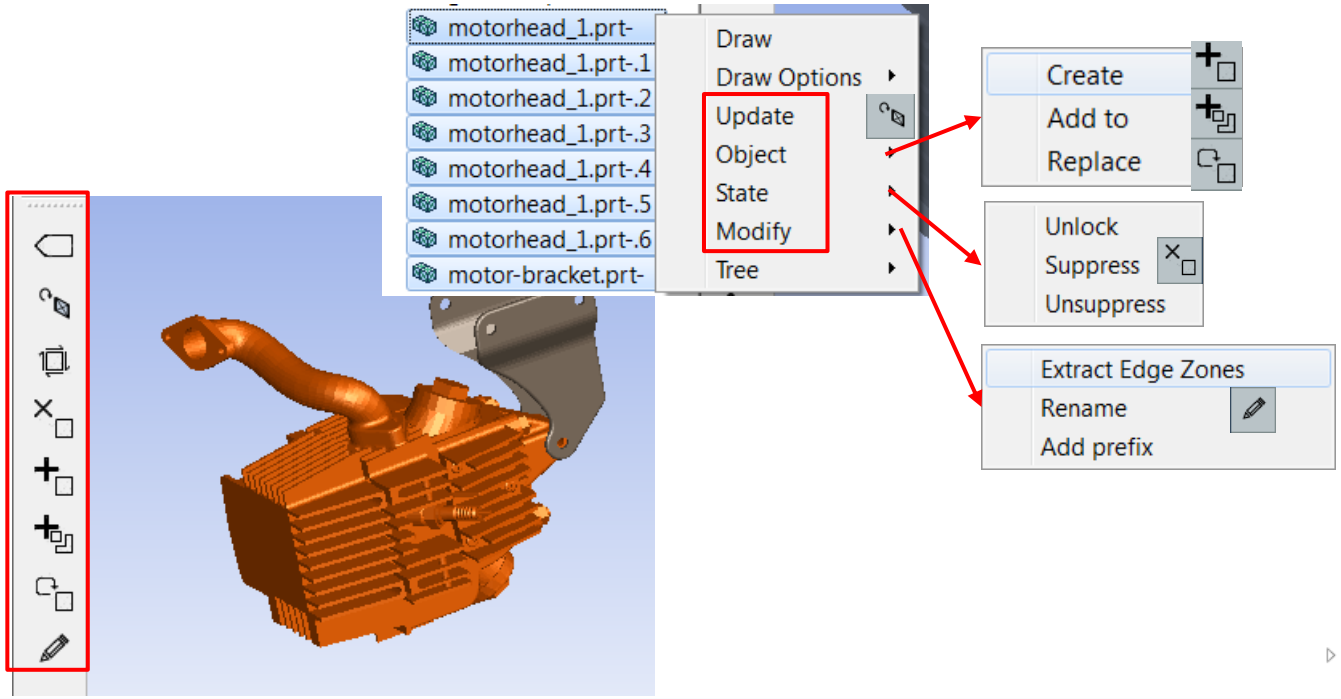


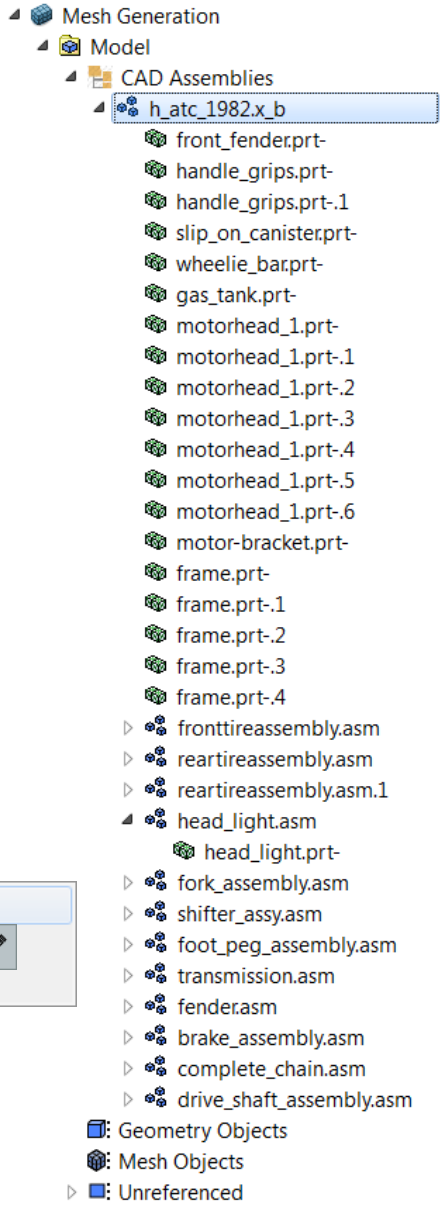
Fluent Meshing功能介绍及竞争优势

CAD导入及管理

CAD Assemblies管理导入CAD

- 可进行绘图显示/更新/对象操作/检查状态/修改

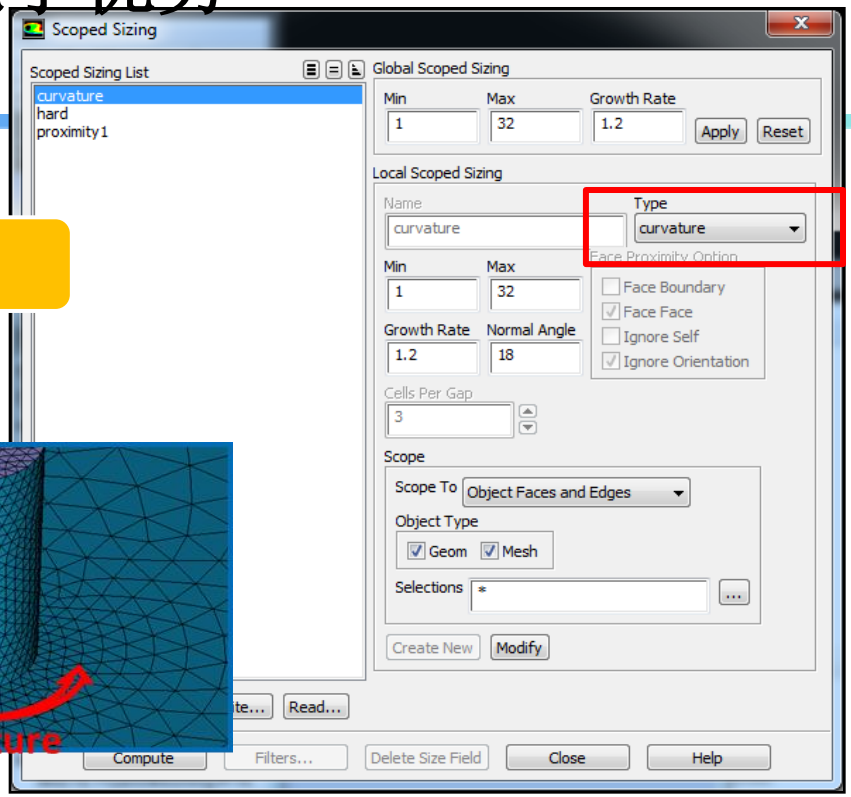




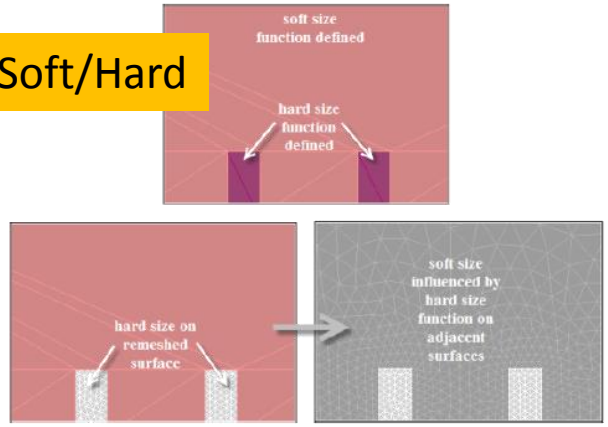
Fluent Meshing功能介绍及竞争优势

尺寸函数

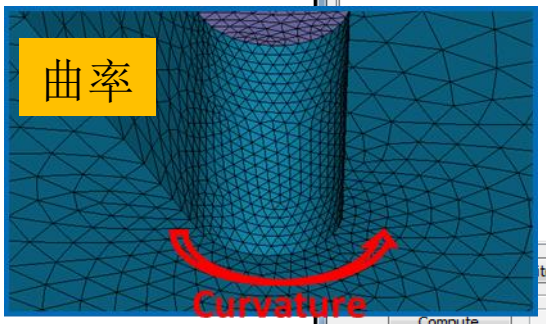
采用scope sizing设置网格尺寸



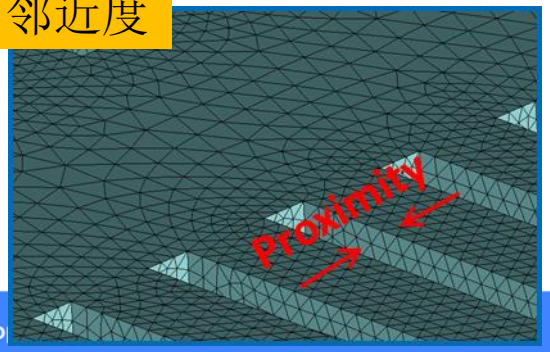
Soft/Hard



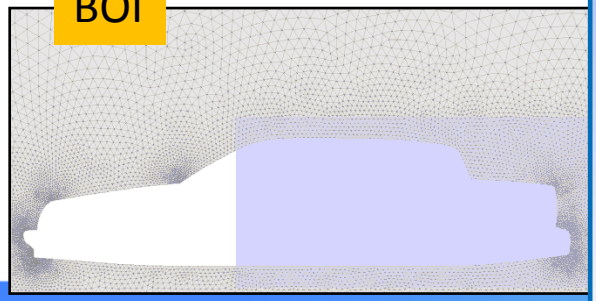
曲率

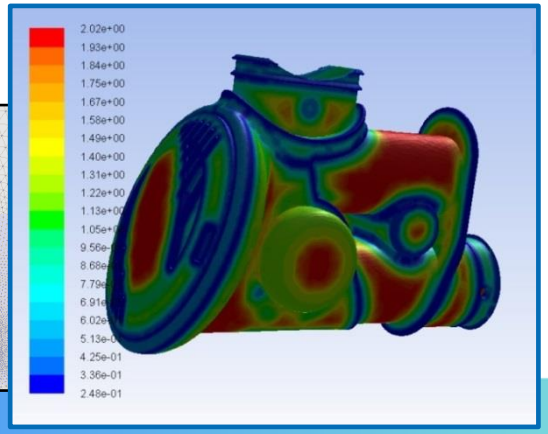


邻近度



BOI



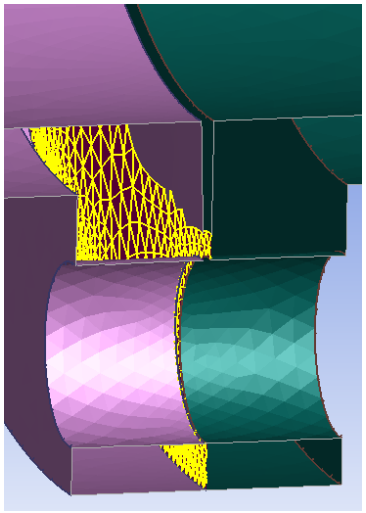


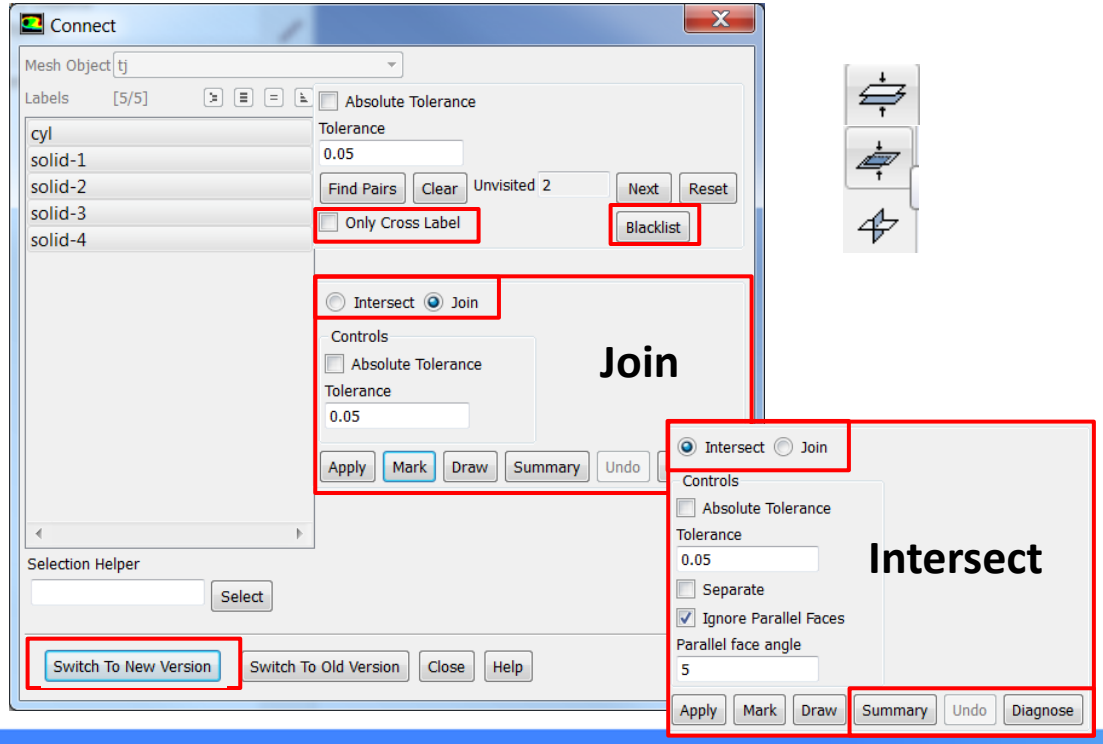
Fluent Meshing功能介绍及竞争优势

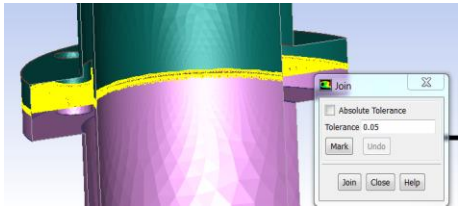
面网格技术

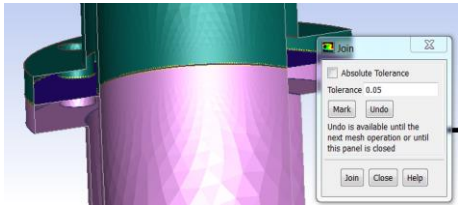
交互式 Gap Closing / Join / Intersect

- 可通过调整容差发现狭缝并封闭
- 可交互式接合/相切表面





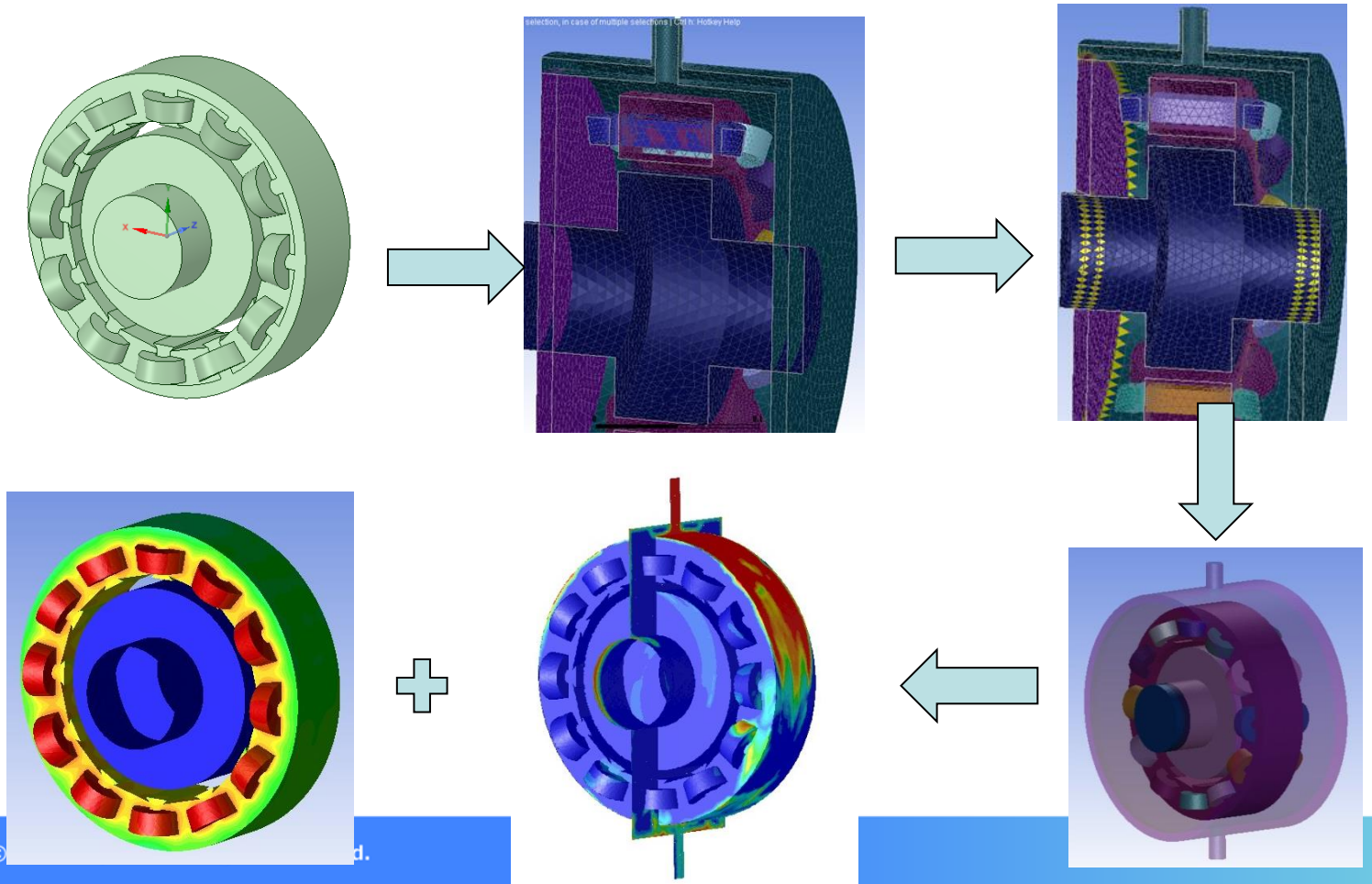




Fluent Meshing功能介绍及竞争优势

面网格技术

案例：某油冷电机散热模型面网格准备 （SpaceClaim + Fluent Meshing）

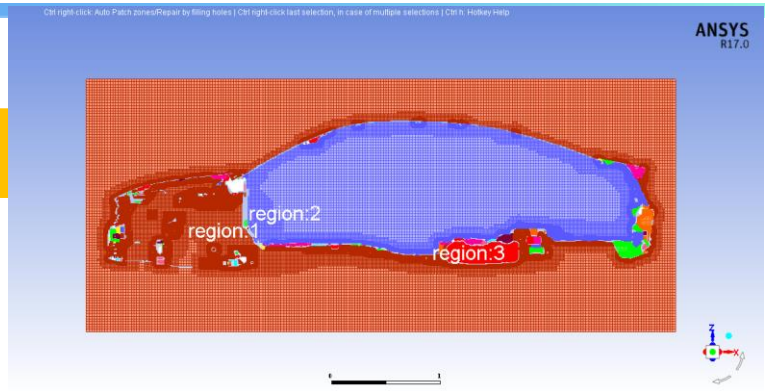


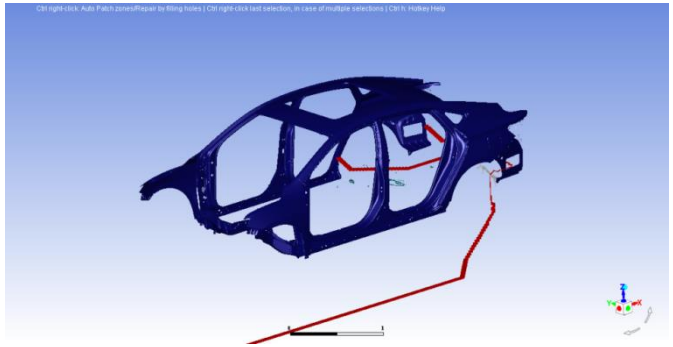
Fluent Meshing功能介绍及竞争优势

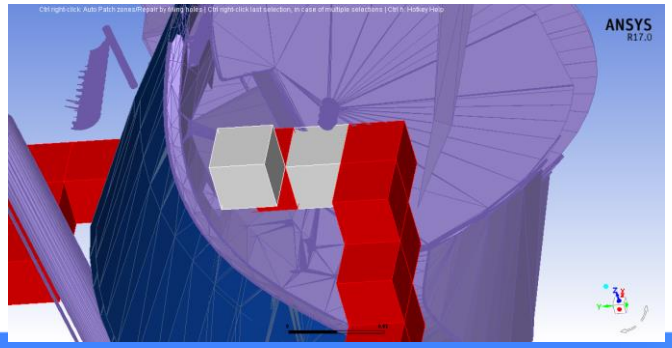
面网格技术

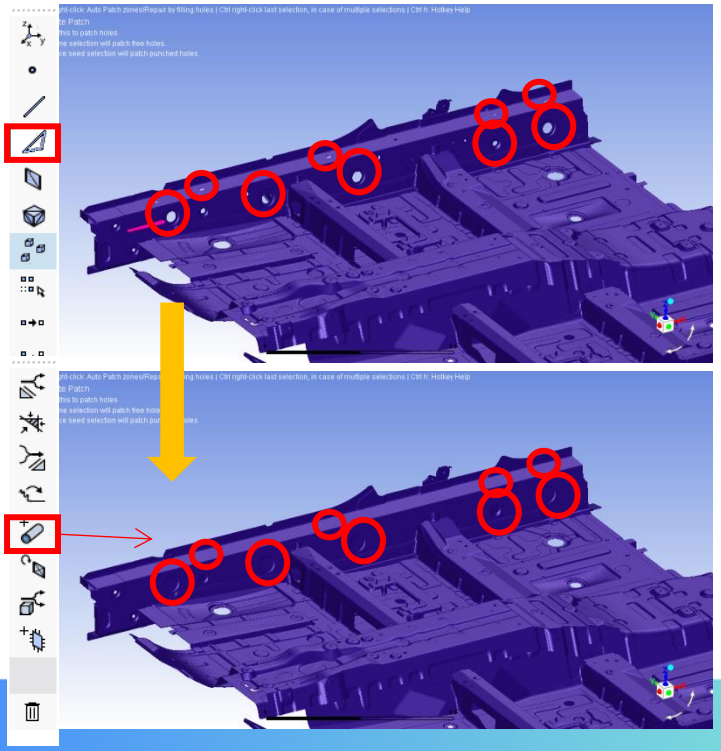
稳健而高质量的包面(含重构)技术

- 支持检漏/快速批量漏洞封闭
- 支持包面后特征复原







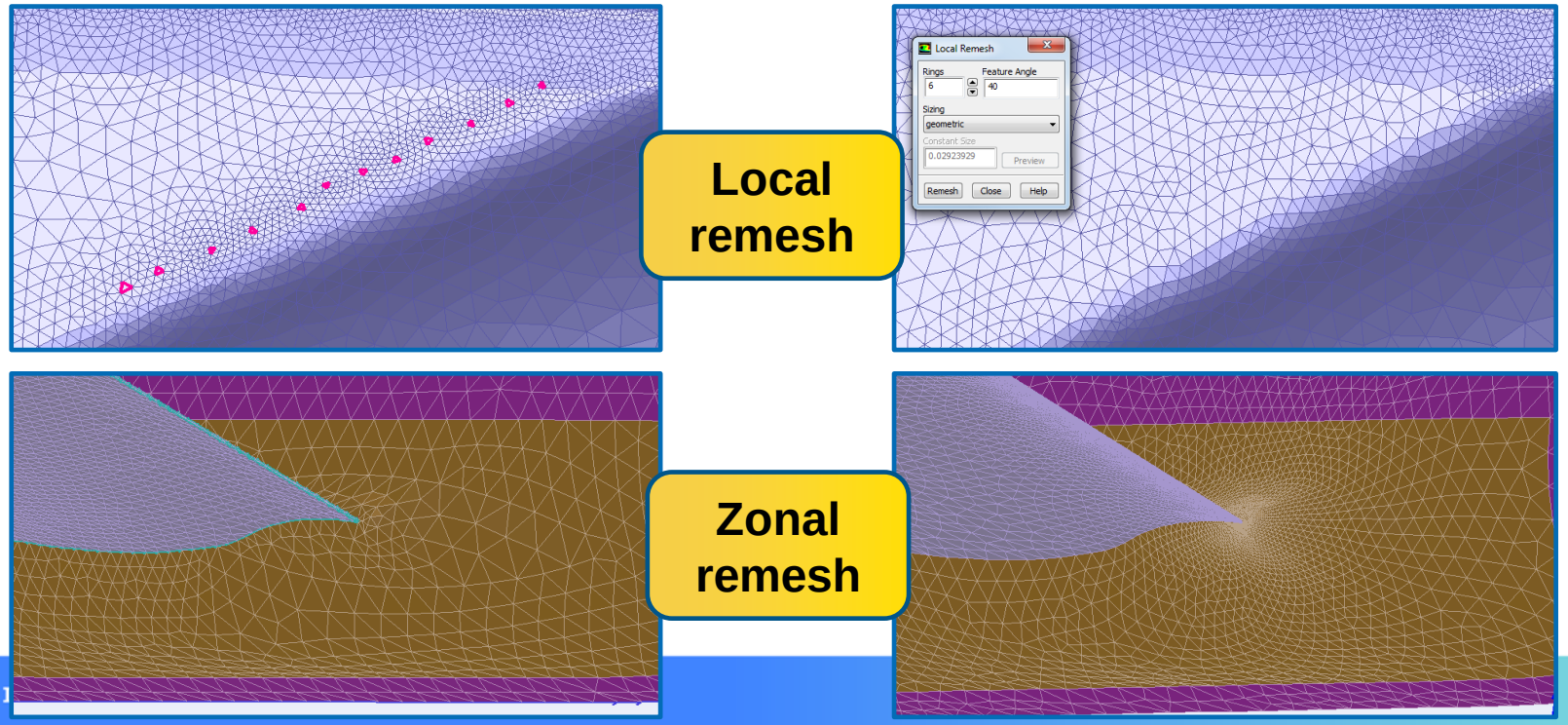


Fluent Meshing功能介绍及竞争优势

面网格技术

表面重构(Conformal)

- 可选择重构的范围：
  - Local (以面face为中心)
  - Zonal (以边界域boundary zone为中心)
- 用户可以Coarsen/refine/smooth当前的面网格

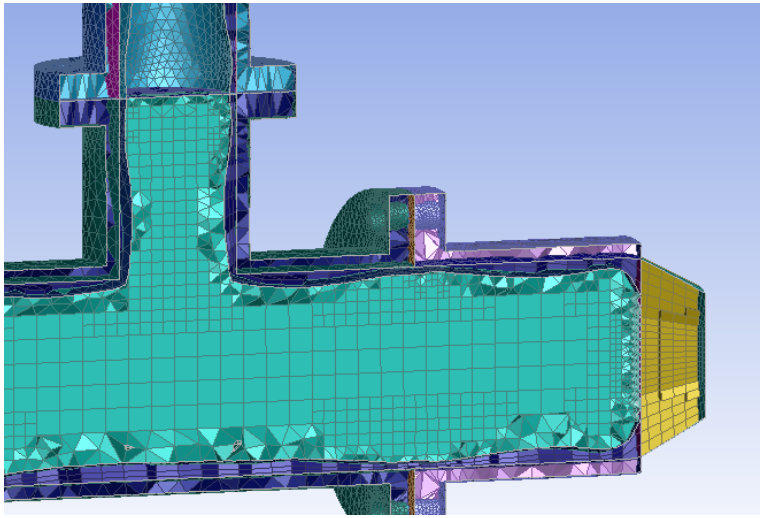


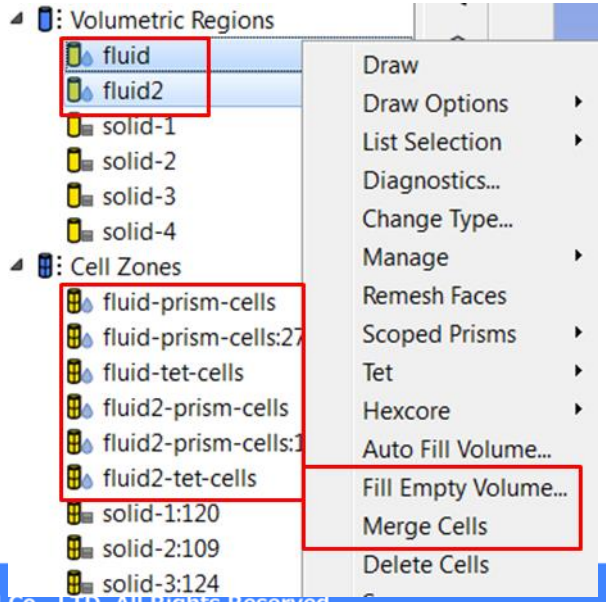
Fluent Meshing功能介绍及竞争优势

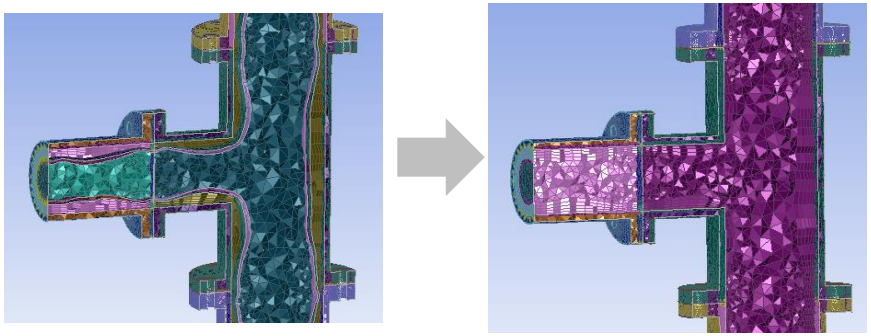
体网格技术

基于域（region）生成网格

- 能够选择性生成一个或多个域（ 的体网格
- 部分域网格生成 (beta)
- 支持四边形网格和六面体网格





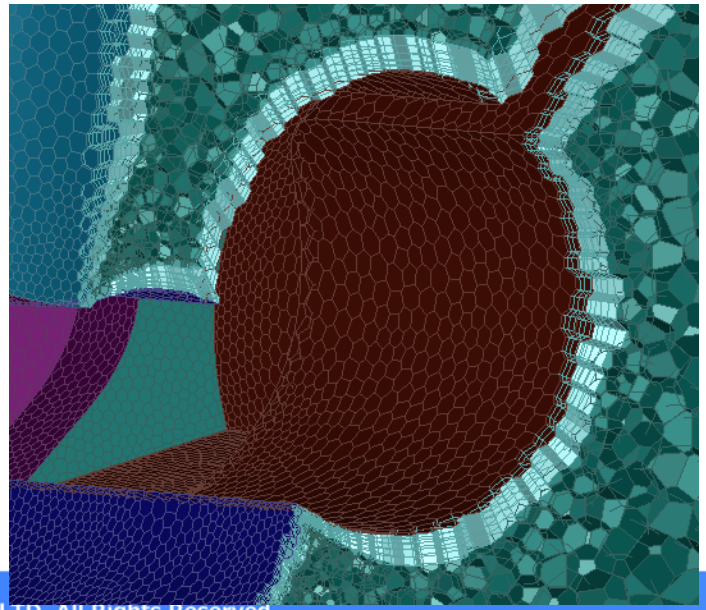


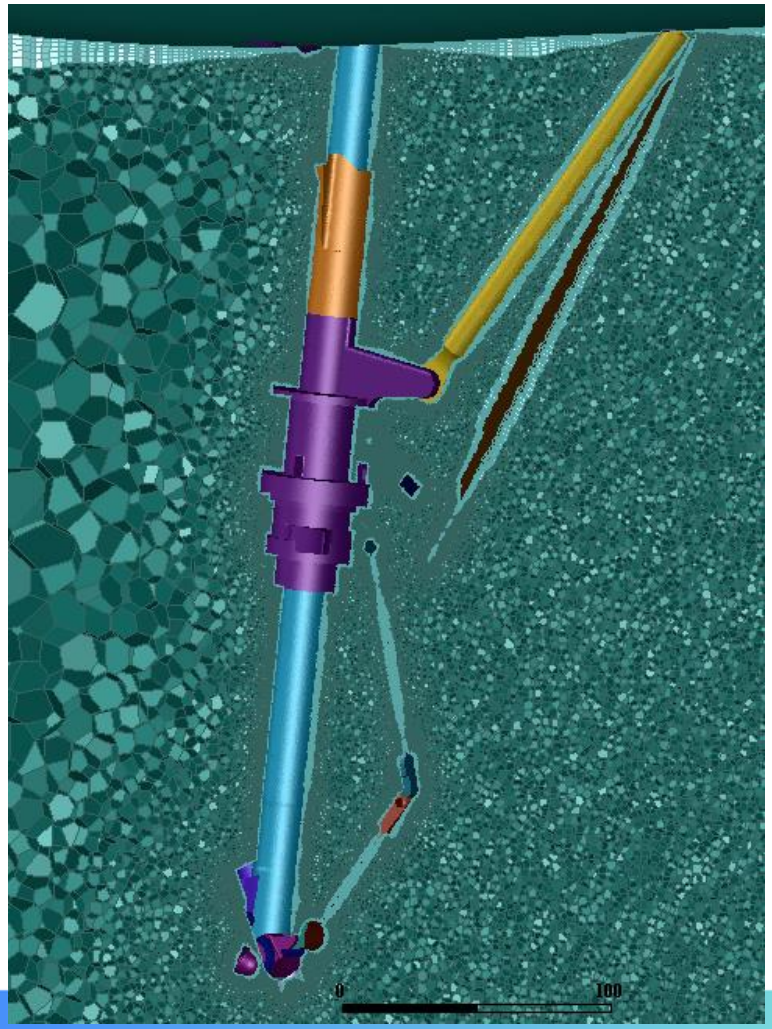
Fluent Meshing功能介绍及竞争优势

体网格技术

直接生成多面体网格

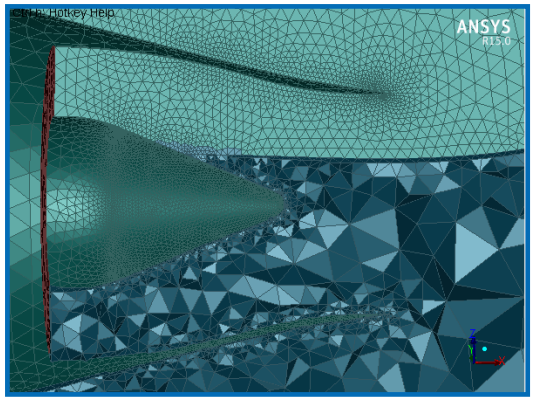
- 现在用户可以直接在Fluent Meshing中生成高质量的多面体网格
- 支持BOI方式加密



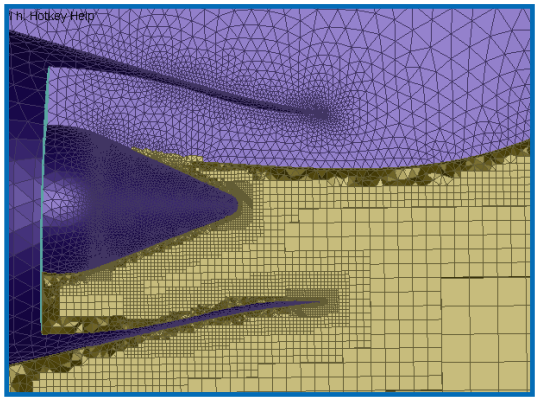


Fluent Meshing功能介绍及竞争优势

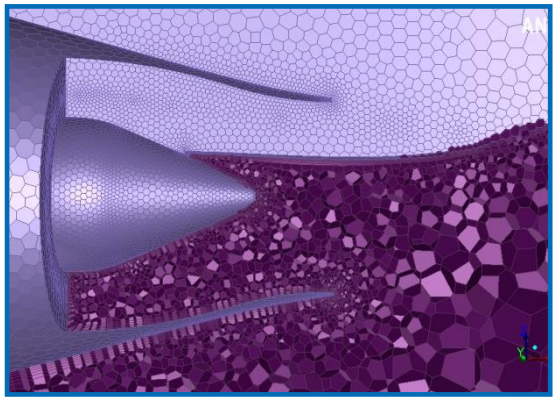
体网格技术



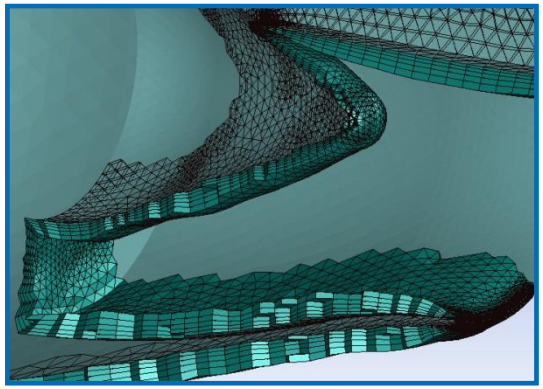
Tet



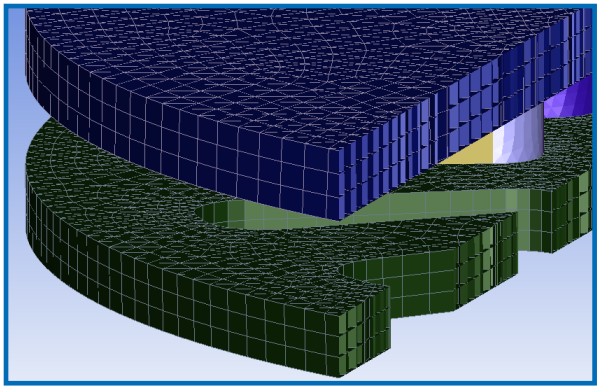
Hexcore



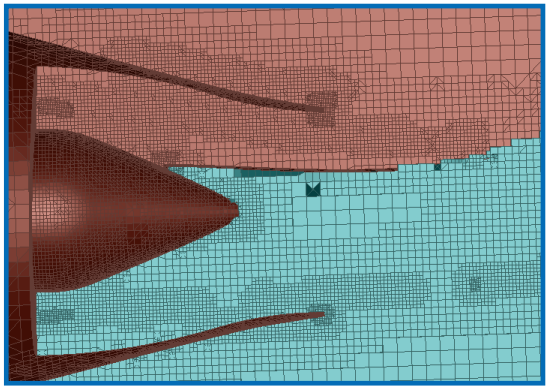
Native Poly



Prisms



Thin Volume



CutCell

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- 总结

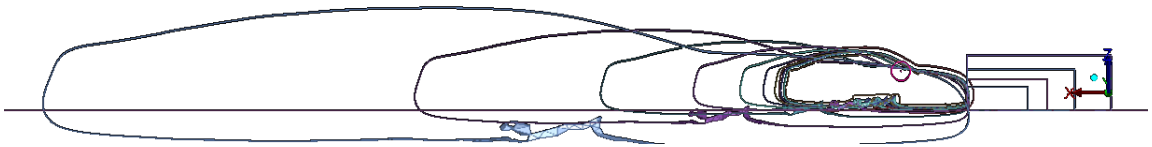
Fluent Meshing功能介绍及竞争优势

脚本化执行

脚本的功能

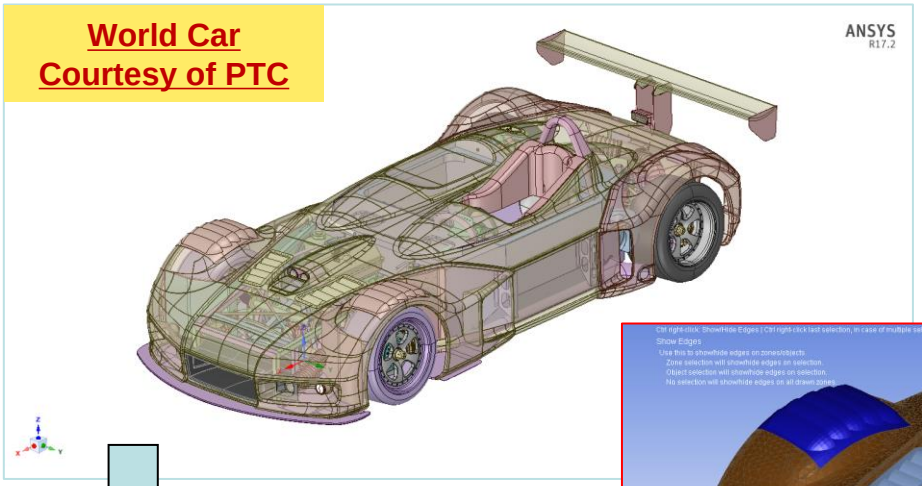
- 几何表面缝隙的封闭
- 自动创建网格加密区域
- 拉伸零厚度表面
- 复杂几何漏洞封堵
- 忽略小特征
- 生成体网格含边界层（各种类型）
- 生成流/固耦合网格
- ……

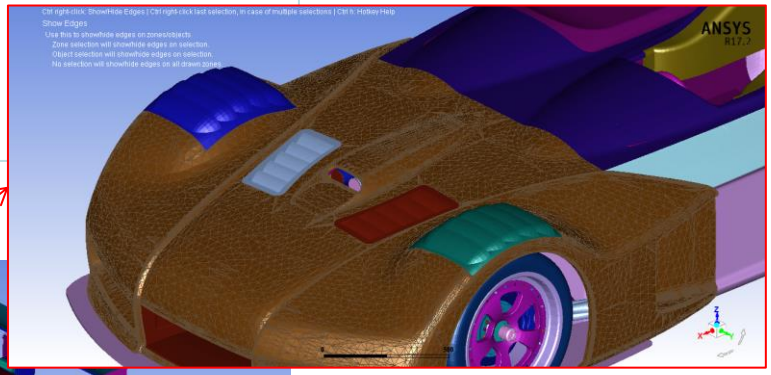
- **AdvWrapNPrisms_R16R17_vXXX_UserInputs.scm**
  - 这个是用户输入scheme文件，用户只能修改这个文件
- **AdvWrapNPrisms_R16R17_vXXX_Run.scm**
  - 这个是运行scheme文件，其中函数被定义在.bin文件
- **AdvWrapNPrisms_R16R17_vXXX_AdvSettings.scm**
  - 这个是高级设置并且对于大多数案例采用默认设置
- **AdvWrapNPrisms_R16R17_vXXX_Main.bin**
  - 这个是主要的scheme文件，它定义了全部函数
- **AdvWrapNPrisms_R16R17_vXXX_Main_Load.scm**
  - 它将加载.bin文件

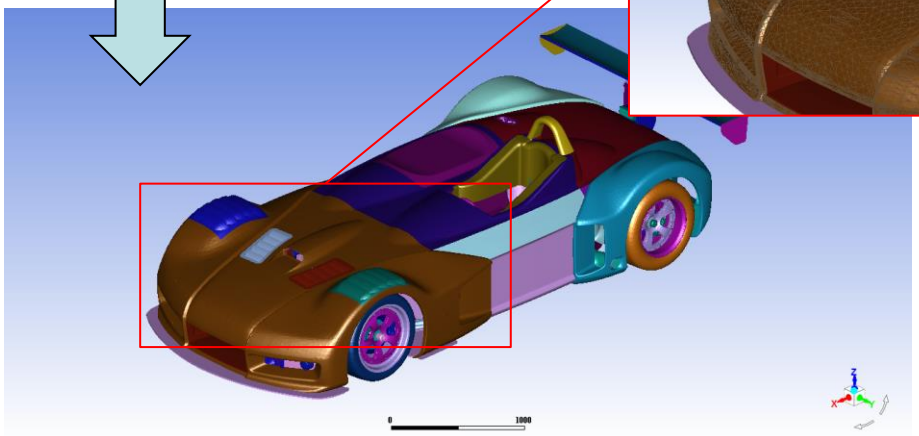


Volvo

案例：脚本化执行流程







Import Geometry

Define/Modify Objects

Define / Modify Features

Define Material Points

Apply Prism Settings

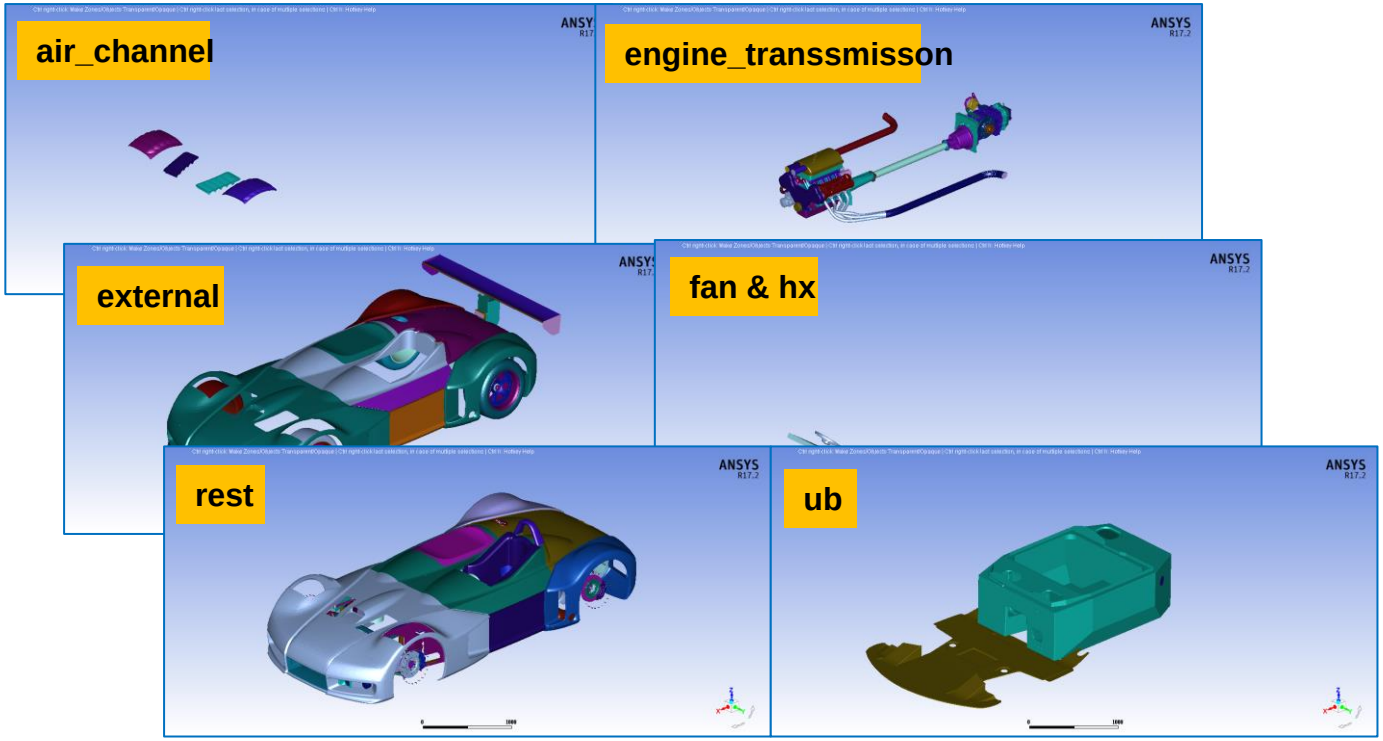
Assign Sizes (Size Functions)

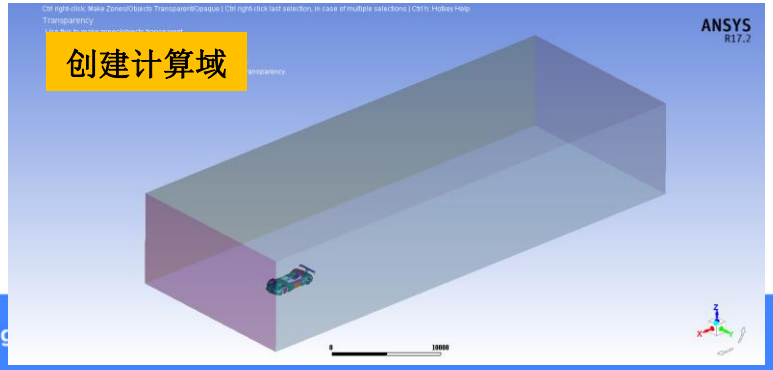
Edit User Input

Run Script

Fluent Meshing直接读取SCDM

案例：脚本化执行流程





- Import Geometry
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- Edit User Input
- Run Script

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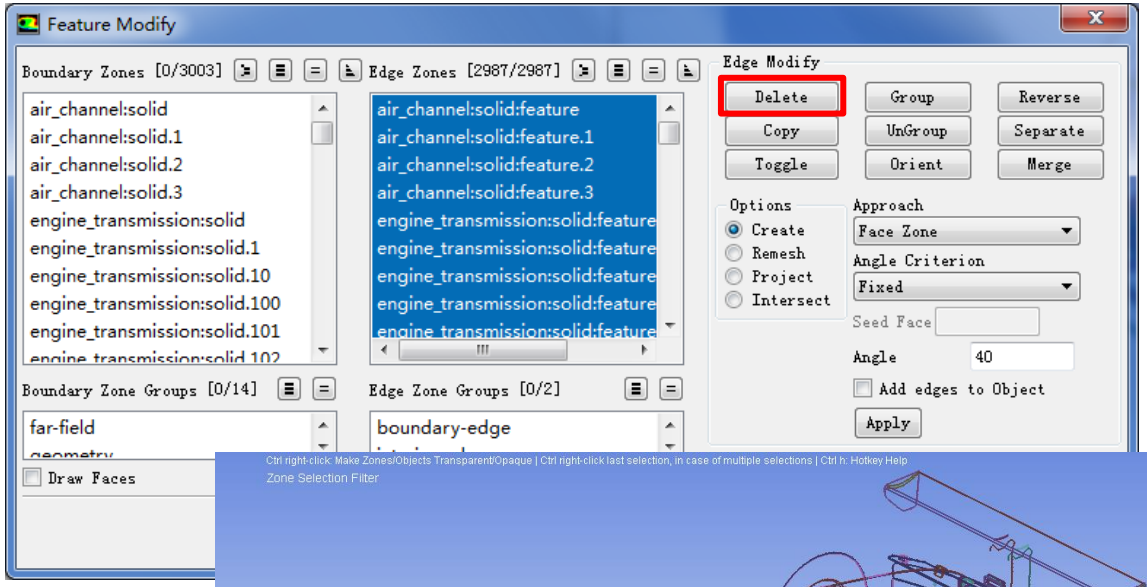

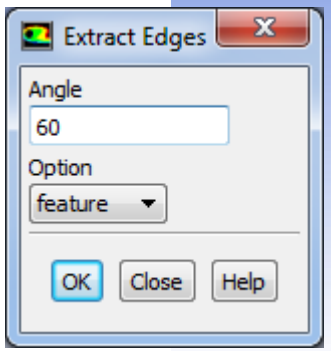

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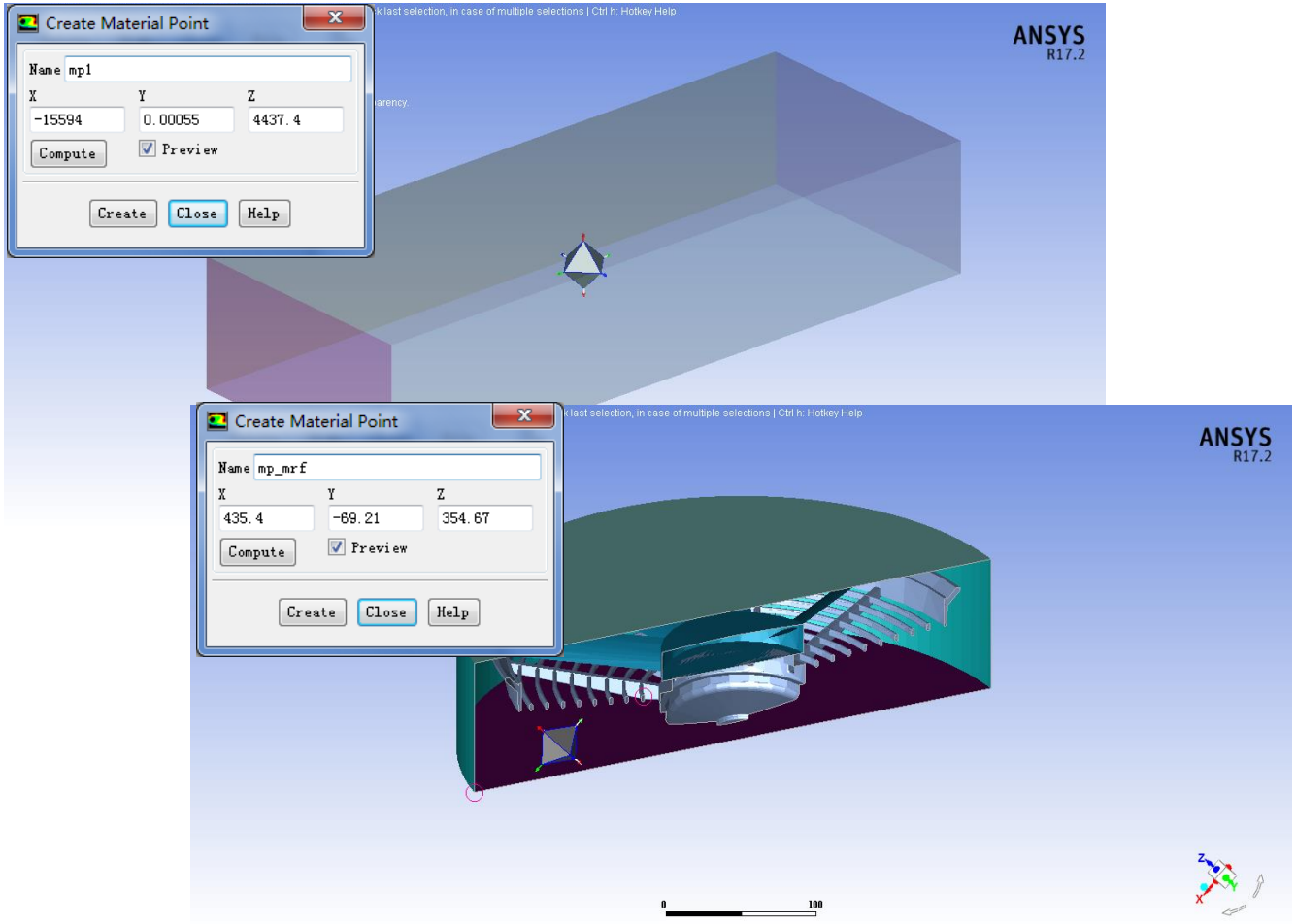

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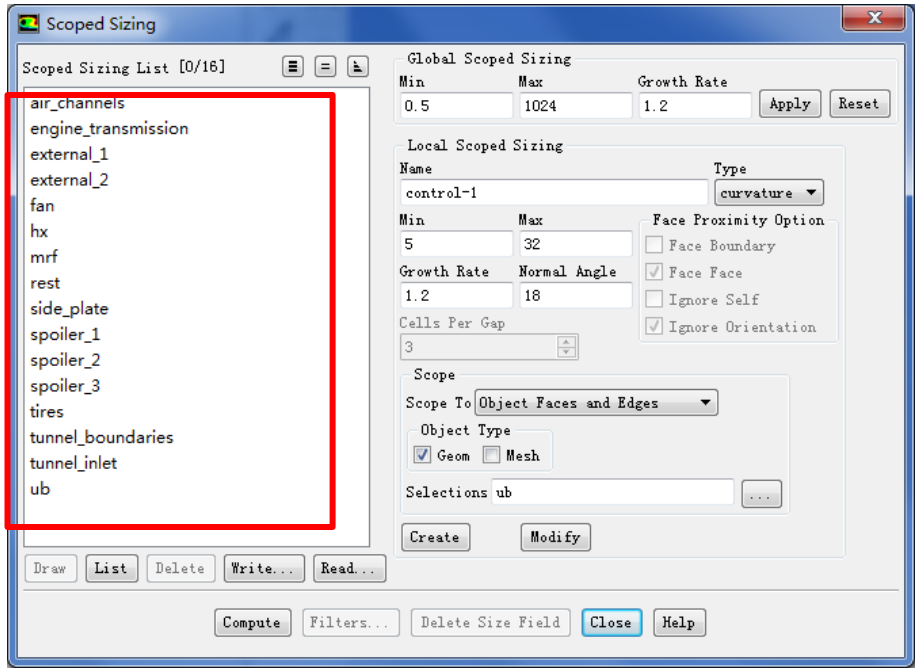

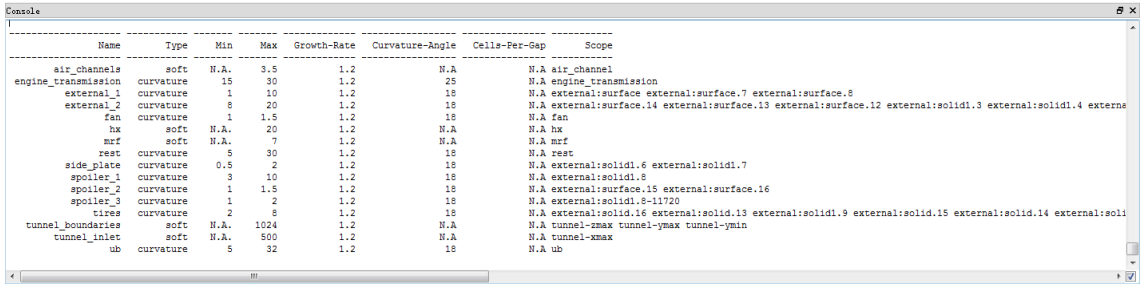

Name	Type	Min	Max	Growth-Rate	Curvature-Angle	Cells-Per-Gap	Scope
air_channels	soft	N.A.	3.5	1.2	N.A	N.A	air_channel
engine_transmission	curvature	15	30	1.2	25	N.A	engine_transmission
external_1	curvature	1	10	1.2	18	N.A	external:surface external:surface.7 external:surface.8
external_2	curvature	8	20	1.2	18	N.A	external:surface.14 external:surface.13 external:surface.12 external:solid1.3 external:solid1.4 externa
fan	curvature	1	1.5	1.2	18	N.A	fan
hx	soft	N.A.	20	1.2	N.A	N.A	hx
mrf	soft	N.A.	7	1.2	N.A	N.A	mrf
rest	curvature	5	30	1.2	18	N.A	rest
side_plate	curvature	0.5	2	1.2	18	N.A	external:solid1.6 external:solid1.7
spoiler_1	curvature	3	10	1.2	18	N.A	external:solid1.8
spoiler_2	curvature	1	1.5	1.2	18	N.A	external:surface.15 external:surface.16
spoiler_3	curvature	1	2	1.2	18	N.A	external:solid1.8-11720
tires	curvature	2	8	1.2	18	N.A	external:solid.16 external:solid.13 external:solid1.9 external:solid.15 external:solid.14 external:soli
tunnel_boundaries	soft	N.A.	1024	1.2	N.A	N.A	tunnel-zmax tunnel-ymax tunnel-ymin
tunnel_inlet	soft	N.A.	500	1.2	N.A	N.A	tunnel-xmax
ub	curvature	5	32	1.2	18	N.A	ub

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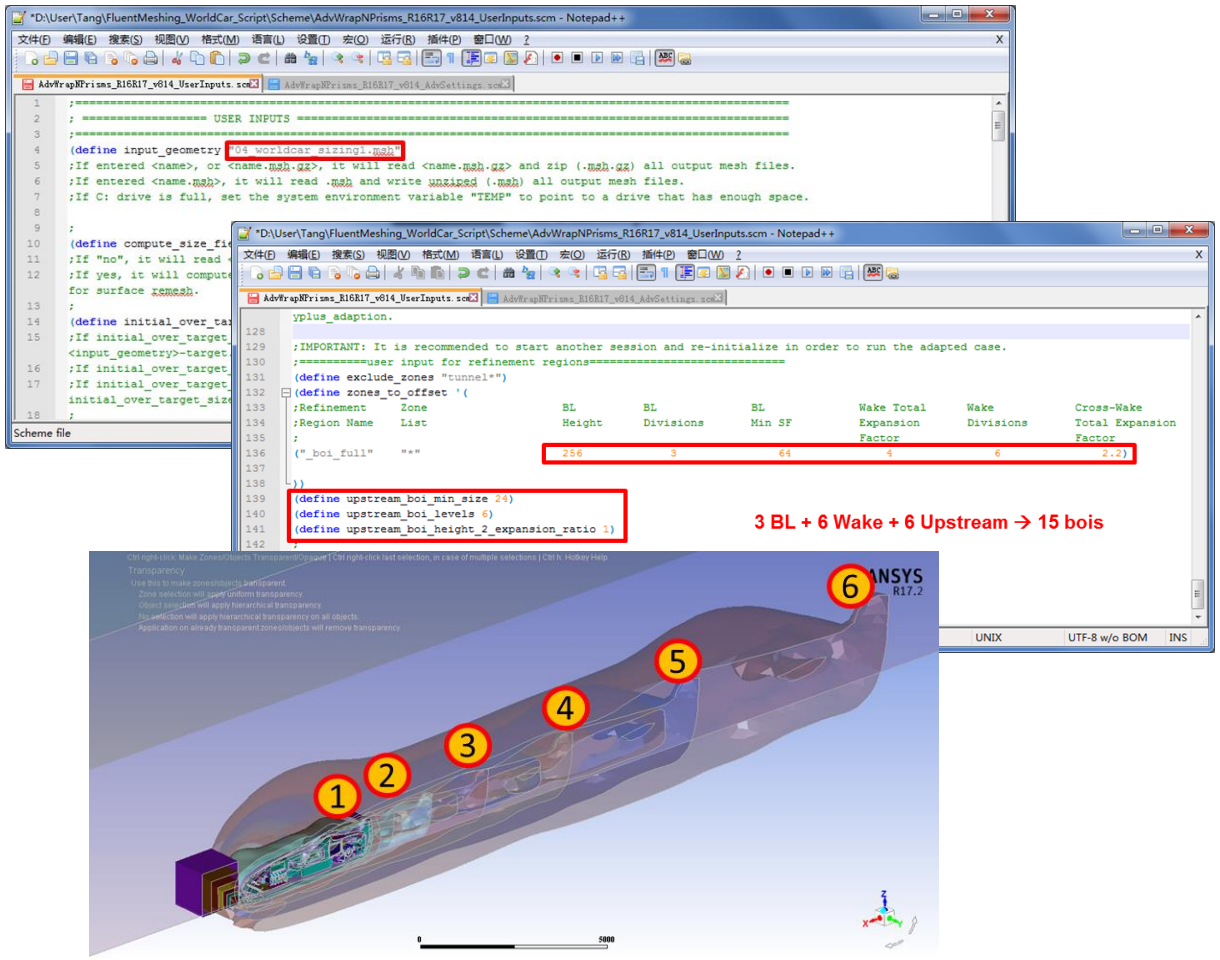

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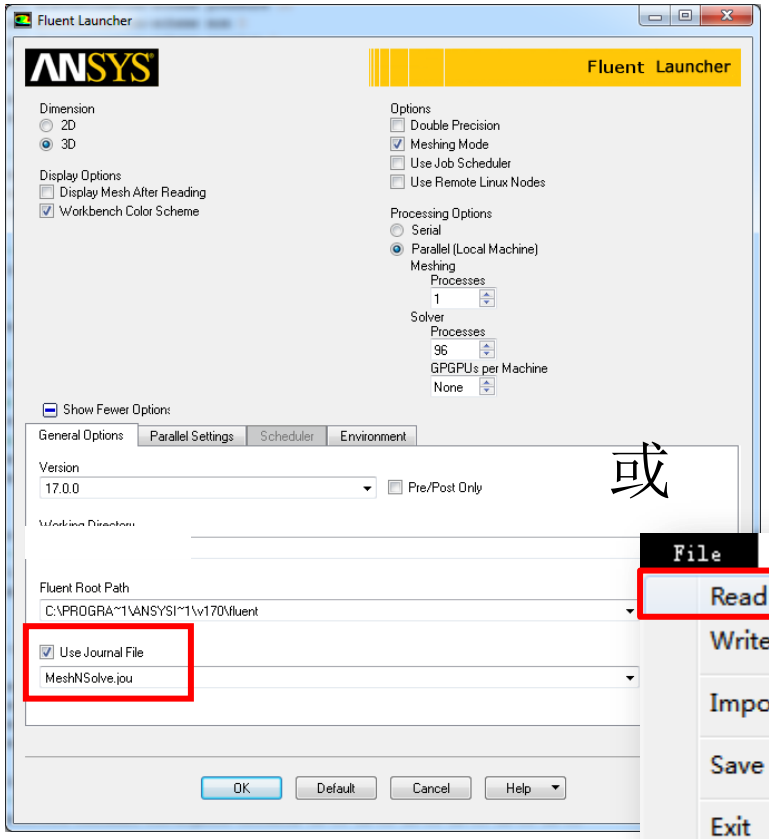
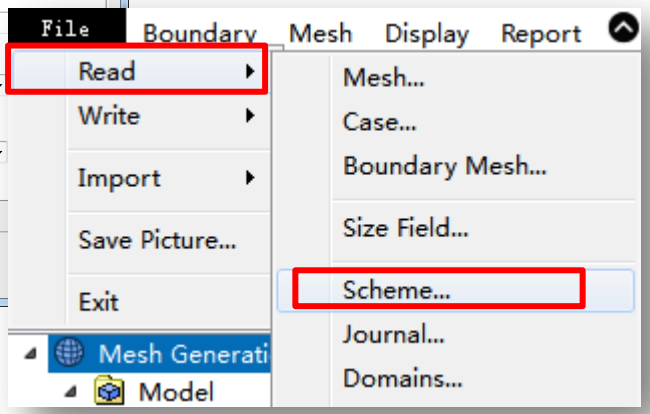


或



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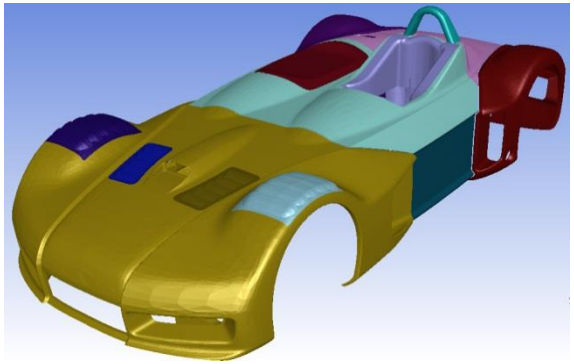
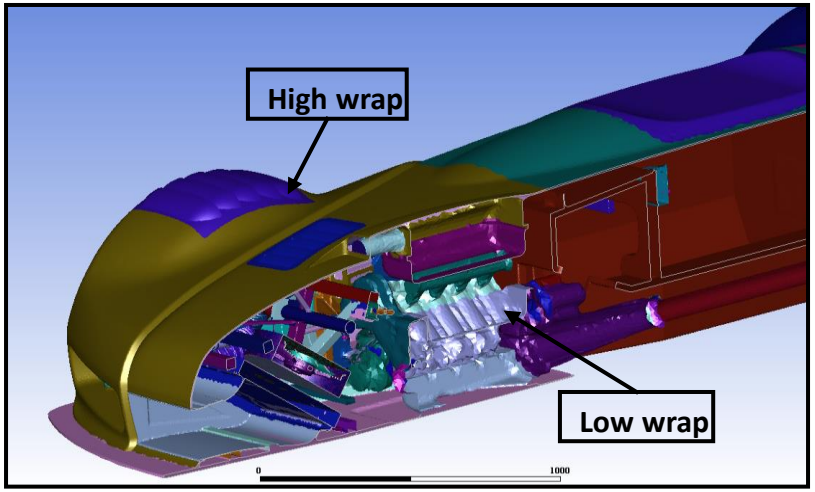
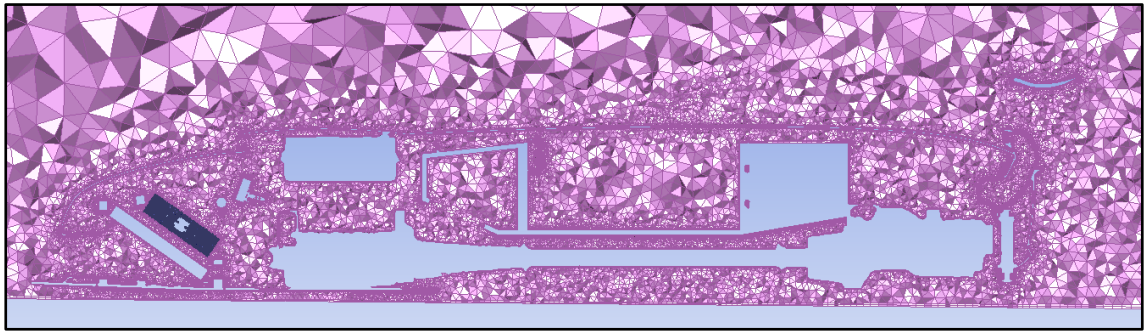
Fluent Meshing功能介绍及竞争优势

脚本化执行





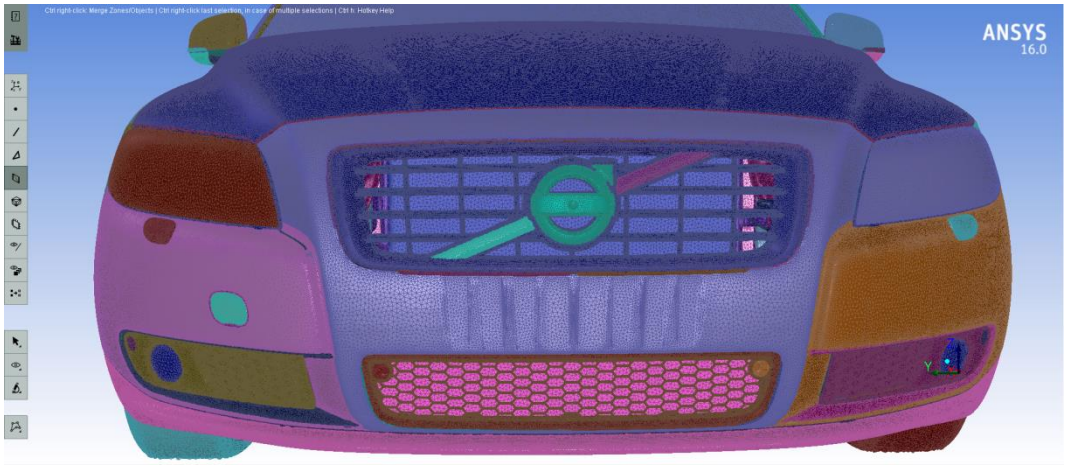


Fluent Meshing功能介绍及竞争优势

脚本化执行

2015 Automotive Simulation World Congress

Application	Objective	Cell Count	Peak RAM (GB)	Effort
Loader Machine	FEAF	28 million tet (2 layers)		1 day
Small Truck	FEAF	46 million tet (2 layers)		1 day
Oven	Flow Rate	55 million tet (3 layers)		1.5 days
1/8th Scale Truck and Trailer	External Aero + FEA	40 million hexcore	24	1 day
Full-Scale Truck and Trailer	Aero	95 million hexcore (3 layers)	??	1 day
Wind-Turbine	Aero	46 million (10 layers)	21	0.5 day
Combustor (1 sector)	Aero	54 million (6 layers)	24	0.5 day
Nacelle	Aero	45 million (4 layers)	20	1 day
Oil F				
Passenger Car	Aero	170 million (21 max layers - all adapted)		
Volvo S80	Aero	95 million (2 layers)		2-3 days
Motorcycle	UTM	10 million (2 layers)		< 0.5 day



Volvo S80	Aero	95 million (2 layers)		2-3 days

Advances in Robust, Automated Meshing and Solving Methods for Vehicle Aero-Thermal Simulations, Hamid Ghazialam, ASWC2015

Fluent Meshing功能介绍及竞争优势

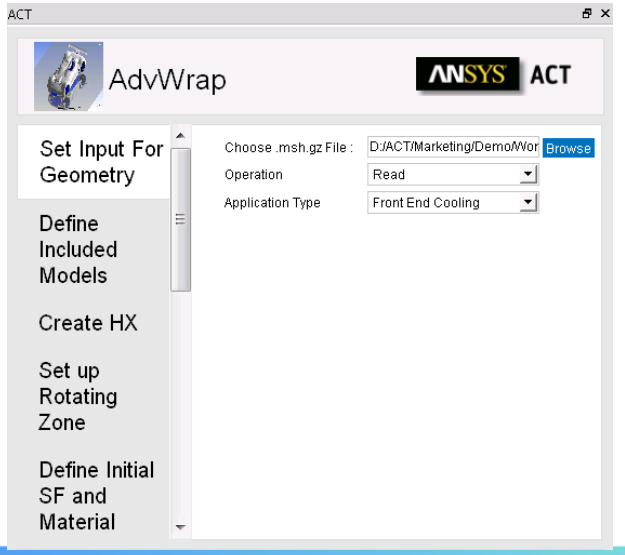
ACT定制包面(AdvWrap ACT)

什么是 AdvWrap ACT

- 一种基于ANSYS Fluent Meshing包面和体网格技术开发的专门针对复杂工程模型自动化(半自动化)前处理流程；
- 针对不同应用内嵌最佳网格实践可以快速完成案例设置
- 采用集成式工作流程，用户输入参数少
- 在流程执行中使用Excel工作表来记录参数以及重新调用输入参数

针对整车领域，用于两种主要应用

- 外流空气动力学 – 车辆气动性能分析
- 机舱热管理 (UTM) – 用于分析各种工况下车辆的热状况
  - 基础UTM分析 – 前端冷却分析 (Front End Cooling)
  - 完整UTM分析 – 整车级CHT分析



Fluent Meshing功能介绍及竞争优势

ACT定制包面(AdvWrap ACT)

工作流程

输入几何并设定计算类型

↓

设置Porous 和Rotating Zones (可选)

↓

通过Material Point定义流体域，通过Size Function定义尺寸分布

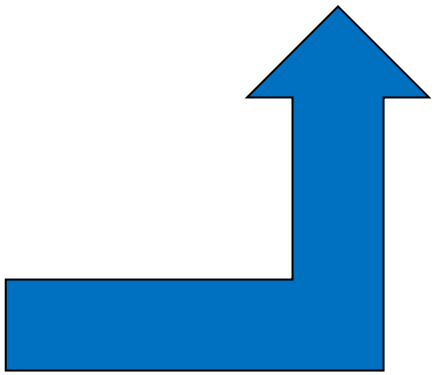
↓

通过Excel工作表设置Wrapping和Volume meshing参数

用户确认计算设定并递交计算

↑

通过模板进行模型案例设置，同时切换至Fluent Solver



自动化执行网格流程。CPU时间随模型复杂度变动。

Fluent Meshing功能介绍及竞争优势

ACT定制包面(AdvWrap ACT)

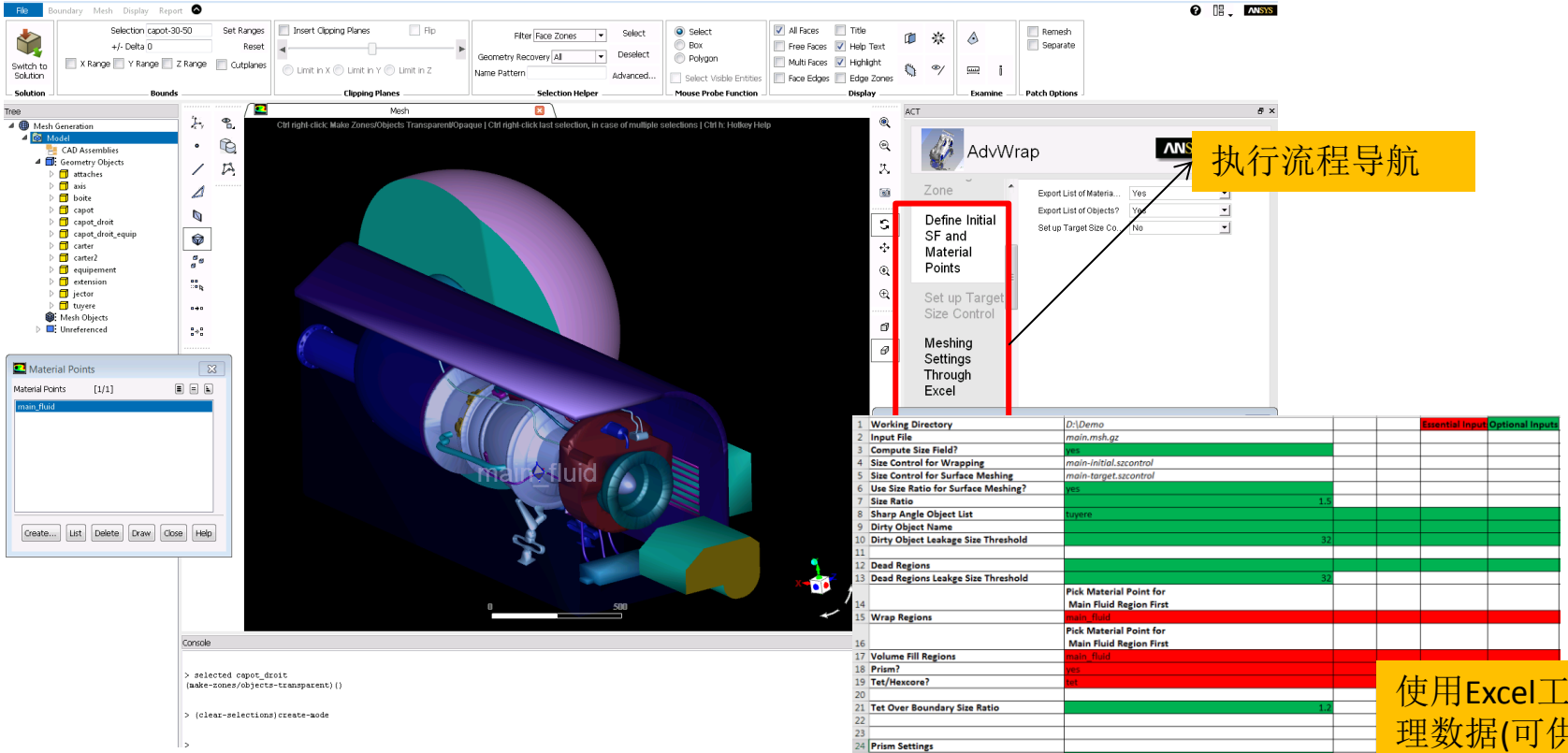


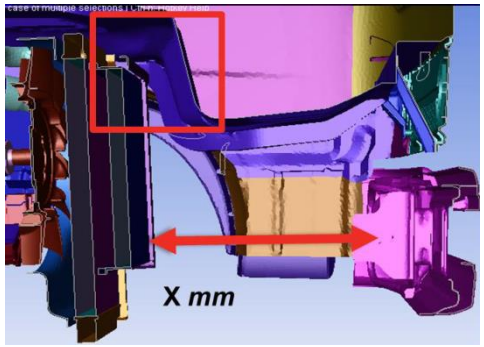
图 安装ACT插件后的Fluent Meshing界面

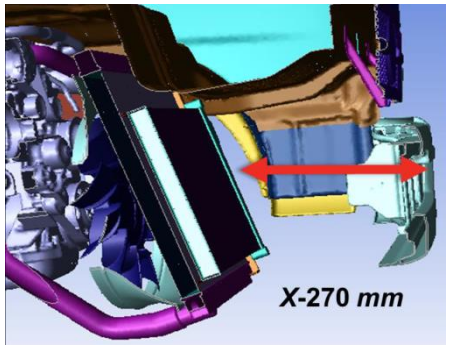
Fluent Meshing功能介绍及竞争优势

ACT定制包面(AdvWrap ACT)

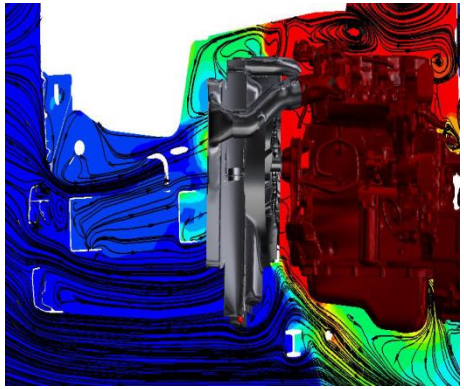
ANALYSIS AND DESIGN VALIDATION OF MEDIUM DUTY TRUCK COOLING SYSTEM

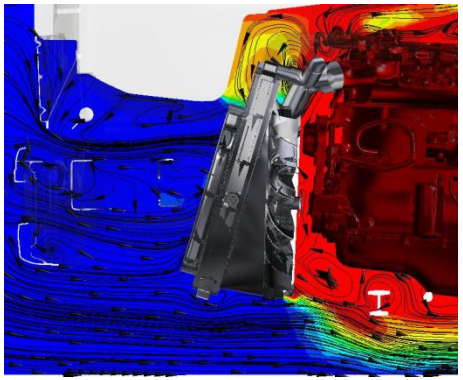
Rohit Saha, Mahesh Kumar, L K Hwang
Cummins Inc.
Fengchao Zhang, Xiaodan Zhang, Liu Yagui
Dongfeng Cummins Engine Co. Ltd.
Weiqing Sun, Yan Wang, Wei Cheng, and Mingjin Lin
Dongfeng Automotive Co. Ltd.
Xingshi Wang
ANSYS Inc.





基础模型和改进模型





流场和温度场结果

目录

总结及致谢

- Fluent Meshing提供了完整的从CAD到体网格的工作流程，并可进行脚本化驱动的快速网格生成，适合于处理大规模复杂模型并极大缩短人工时间，AdvWrap ACT更有助于提升用户易用性。Fluent Meshing的不断开发进步配合求解器的稳健性和高精度，体现了Fluent对客户的不变承诺。

- IDAJ-China基于自身多年的CAE/CFD经验，可以为用户提供”量身定制”的ANSYS Fluent培训和技术支持

- 感谢IDAJ同事**陈桂杰、吴成涛**提供的素材，感谢ANSYS的**Mohib Khan、马世虎**提供案例。

感谢聆听！